

FEBRUARY 1984

PROCESS LANES
FEASIBILITY STUDY

U. S. DEPARTMENT OF TRANSPORTATION
MARITIME ADMINISTRATION

IN COOPERATION WITH
AVONDALE SHIPYARDS, INC.: NEW ORLEANS, LOUISIANA

Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE FEB 1984		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Process Lanes Feasibility Study				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Surface Warfare Center CD Code 2230 - Design Integration Tools Building 192 Room 128 9500 MacArthur Bldg Bethesda, MD 20817-5700				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 110	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

R. A. PRICE - CONTRIBUTING AUTHOR
AND EDITOR

TERMINOLOGY ANALOGY

<u>Committee Report Terminology</u>	<u>Past A.S.I. Terminology</u>	<u>I.H.I. Corresponding Terminology</u>	<u>End Product Terminology</u>
Pre-Fabrication	Pre-Fabrication	Fabrication	Pieces
Fabrication	Fabrication	Sub-Assembly	Partial Sub Unit
Sub-Assembly	Main Assembly	Assembly	Sub Unit
Main Assembly	Main Assembly	Grand Assembly	Unit

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FOREWORD

A Process Lane System is reported on here. It offers cost-saving features and practical benefits to shipyards. Increased productivity is the goal and purpose of the Process Lanes. The plan is, in part, a response to an industry priority set forth by the Merchant Marine Act of 1970:

To improve shipbuilding productivity and reduce shipbuilding costs while maintaining requisite high standards for critical processes and operations.

It is anticipated that the results of this preliminary examination will demonstrate to the shipbuilding industry, through the Society of Naval Architects and Marine Engineers (SNAME) Facilities Panel SP-1, the Maritime Administration, and the U.S. Navy, that the development and implementation of Process Lanes as recommended fulfills all criteria for cooperative program continuation as defined by the National Shipbuilding Research Program.

The importance of this project would be even further emphasized by a full roster of all who gave time and knowledge to aid project research and planning. Among numerous individuals to whom credit and thanks are due, those whose names follow warrant particular acknowledgement for both significant contributions and ongoing involvement with this project's concept, planning, progress, and positive results.

Executive administration and supervision were provided by O. H. Gatlin, Vice President, Corporate Plant Engineering and Maintenance, Avondale Shipyards, Incorporated; with R. A. Price, MarAd Research and Development Program Manager, Avondale Shipyards, Incorporated.

A special advisory group consisted of T. Hamasaki, I.H.I., S. Katsu, I.H.I., and A. Hunt, A.S.I.

Advisory Committee responsibilities were fulfilled by the following officers of Avondale Shipyards, Inc.: A. L. Bossier, President; W. A. Harmeyer, Group Vice President; E. A. Blanchard, Group Vice President Production; C. Starkenburg, Vice President Production; together with J. Garvey and R. Schaffran, Office of Advanced Shipbuilding Development, Maritime Administration.

The Process Lanes Committee was chaired by R. Oehmichen, Avondale Shipyards, Inc. Committeemen were P. Guarino, D. Sours, W. Mayo, V. Nuzzo, P. Roussel, D. Savoie, E. Taylor, and D. Zeringue of Avondale Shipyards, Inc.

EXECUTIVE SUMMARY

OBJECTIVE

The critical goal of this project was the design of a Process Lane System: a system to reduce today's record-high levels of labor cost; to revise usual materials-handling methods to upgrade flow efficiency; and bring about streamlined space requirements for both operations and storage areas. Our goal was a Process Lane System with management controls and visibility which would bring clear positive advances to current shipbuilding practice and enhance today's shipbuilding productivity.

APPROACH

Our technical approach to this project has fulfilled the stated objectives of the National Shipbuilding, Research Program as established by the Merchant Marine Act of 1970. Our project determination at its conclusions: that the concept of Process Lanes is not merely a possible productivity tool for shipyards some time in the future! It can, in fact, be implemented today! It can offer tangible-benefits. It is practical. It is workable. It is feasible.

CRITERIA

The following list of functional criteria together describe the Process Lanes. Its features can be considered individually, as a system in total, or as "components" capable of varying use combinations. Flexibility, then, is offered, among other advantages since the system can be implemented or set up incrementally.

CONCEPT

The basic rules of true Process Lanes is to complete similar work at the same location repeated over and over again. Process Lanes establish the greatest amount of "learning curve" efficiency by

having the same people at the same work station doing the same type of work every day with a constant organized efficient flow of material.

UNIT CATEGORIES "MAJOR"

Six unit configurations were established. Consideration involved the size, shape, weight and assembly procedure of the units that make up the hull of a vessel:

<u>Category</u>	<u>Nomenclature</u>
(1)	Flat Panel Unit
(2)	Curve Shell Unit
(3)	Superstructure Unit
(4)	Fore and Aft Peak Unit
(5)	Engine Room Unit
(6)	Special Weldment Unit

PROCESS LANES "MAJOR"

Using the unit categories as criteria, site locations were determined with great consideration given to material flow; therefore, six major Process Lanes were designated:

<u>Category</u>	<u>Main Assembly</u>	<u>Sub-Assembly</u>
(1)	Platen 20	Platen 20
(2)	Platen 17	Platen 17
(3)	Westwego Platens 2, 9, 11	Same
(4)	Platens 10, 13 Area 307	Same
(5)	Platen 14	Platen 14
(6)	Platen 19	Platen 19

UNIT BREAKDOWN

Work volume at each production stage, including platen loading, efficiency tracking, and reporting systems, were determined.

MATERIAL FLOW

Material flow and facility layout analysis were carried out.

CODING SYSTEMS

Piece coding and cost coding systems were defined and developed.

PLANNING AND CONTROL

Schedule planning, including the hull construction plan, contract requirements, and facility capacity loading, were determined.

Planning control under the Process Lanes concept was determined including process, efficiency, and stage plans.

COSTS

The Process Lanes are put to work in real operation by an expenditure from \$400,000 to \$500,000, depending upon the facility. Accurately, however, this capital outlay should be seen as an investment, not a "cost." Its aim is to recover expenditure, then move into a "benefits zone," where efficiency and productivity begin to translate into profits. Consider, for example, that the Process Lanes can produce a savings of approximately 30 percent in the handling of steel. The appropriate cost savings can be obtained by evaluating the manpower, equipment, and energy reductions which will result from a 30 percent reduction in the handling of steel material alone. It has become evident, from this study, that a major reason for process lanes implementation is the need for evolution of an ideal material handling and flow system.

INDEX TO SECTION ONE: PROCESS LANES CONCEPT

1.1 THE REQUIREMENTS OF PROCESS LANES

1.2 UNIT CATEGORIZATION

1.1 THE REQUIREMENTS OF PROCESS LANES

Process Lanes means the categorization and-separation of "like" kinds of work and the development of work centers specifically designed to efficiently and economically produce that kind of work. Process Lanes establish the greatest amount of "learning curve" efficiency by having the same people at the same work centers doing the same type of work every day with a constant organized efficient flow of material.

During this study, it was determined that Process Lanes, as defined above; do not exist at ASI. Instead, different types of units are assembled at the same location. Assembling different types of units at one location requires the following:

1. Different types assembly periods of time.
2. Different types of assembly platens.
3. Different types of construction methods.

When units having different characteristics are produced in the same location, those obstacles must be overcome. This tends to decrease productivity and accuracy. Because of the use of different types of material, the establishment of one site storage becomes very difficult, resulting in increased material handling costs

When Process Lanes are established at ASI, there will be controls to create detailed Process Lanes schedules based on the volume and quantity of work for each Process Lane work center and thereby enable ASI management to determine work center cost and efficiency.

At IHI, industrial engineers are assigned to work centers for each stage of construction, to study and establish detailed work center schedules, collect and monitor actual performances from the work center foreman on a daily basis, and prepare efficiency charts or graphs for management. The charts and graphs will be the controls by which management can determine each work center's cost,. progress regarding schedule, and actual manhours per ton versus projected manhours per ton efficiency.

It is easy to state required changes and to justify change. It is more difficult to bring about change. Many organizations resist change, sometimes quite unconsciously, perhaps because of tradition or habit, or because of insecurity. HEALTHY ORGANIZATIONS WELCOME AND ACTIVELY ENCOURAGE CHANGE WHEN IT IS RELATED TO SENSIBLE LONG TERM STRATEGY. In particular, this organization should see itself evolving to embrace the relevant developments in ship and production technology. This careful evolution must be seen as a function of the organization.

1.2 UNIT CATEGORIZATION

Process Lanes require the units of a vessel to be divided into categories based on their size; shape, weight and method of construction. Each category requires different assembly jigs and specialized tools. Workers who are familiar with building flat units would not be efficient on curved units. Add material flow problems, and you may understand the need for categorization and the establishment of Process Lanes for each category of hull unit.

Categorization of hull components is required, primarily by the Planning Department and later by Shop or Work Center Planners. This will assist in basic and detailed planning and scheduling, as well as establishing an orderly flow of materials. Categorization also allows the determination of where a component will be constructed, as well as elapsed time and control through the Process Lanes. To accomplish this, the hull units are divided into six basic types:

UNIT CATEGORY 1 FLAT PANEL UNITS

These units are comprised of panel line components and assembled on a flat surface as the base of a unit. This flat surface could be a deck, innerbottom, bulkhead or even the shell. Examples would be double bottoms (in the tank or cargo area), cofferdam bulkheads, and wing tank units assembled on flat side shell plate. This category is comprised of relatively simple units, with SHORT CONSTRUCTION. TIME required. The maximum weight would be approximately 140 tons, and Category 1 units usually comprise approximately 50% of the total hull weight, across varied type hulls.

Platen 20 is the most appropriate site for sub-assembly, pre-outfitting and main assembly for these units, due to the direct connection with the panel line. Fabrication for Category 1 units will be accomplished at Platen 23/24. We are recommending that Platen 20 be sub-divided into four (4) stage areas - Sub-Assembly, Pre-Outfitting, Main Assembly, and Final Assembly. To assist Planning and Scheduling, this category has been sub-divided as follows:

CATEGORY 1A

A partial sub-unit, produced at the panel line, moves to the sub-assembly stage where many fabricated floors and girders are added. The sub-assembly is then moved to the pre-outfitting stage where pipe and outfitting items are added, while the assembly is still open. This sub-assembly is then moved to the main assembly stage, where the 1C type shell (produced at the panel line) is fitted, to close in the unit.

CATEGORY 1B

A partial sub-unit, produced at the panel line, moves to sub-assembly where only two or three web frames are added. The sub-assembly then moves to pre-outfitting, if required. This unit may or may not have a 1C type panel fitted to close it in. NOTE : Fitting and welding lengths of a type 1B are about half that of a type 1A sub-assembly and require less work in the Process Lane. This is extremely important to the planning engineers when developing the platen schedule.

CATEGORY 1C

A partial sub-unit, produced at the panel line, that moves to the main assembly to close in a type 1A or 1B sub-assembly.

UNIT CATEGORY 2 CURVED SHELL UNITS

These units are assembled on curved shell, knuckled longitudinal bulkhead, or innerbottom in fixed or pin jigs. Units assembled in pin jigs are 2A and in fixed jigs are 2B. Examples would be wing

tanks or outboard sections of wings- assembled on curved shell plate or, possibly, knuckled longitudinal bulkheads. The maximum weight would be 120 tons with the units located close to the roadway for mobile crane access.

Platen 17 was chosen as the appropriate site for sub-assembly, pre-outfitting and main assembly due to its relationship with the panel line and plate shop. Curved panel sub-assemblies for the other category units may also be assembled on this platen. Fabrication for this category will be accomplished on Platen 16.

UNIT CATEGORY 3 SUPERSTRUCTURE TYPE-UNITS

These units are typically those built on a deck or flat, as the base of the unit. Bulkheads, stanchions and side shells, along with all pre-outfitting, are accomplished. These units remain in main assembly for longer periods of time than Categories 1 or 2 units. Examples would be superstructure decks, hull decks or flats - with bulkheads, stanchions and side shell, and even stacks, pilot house assemblies or, in some cases, vent house. The assembly and fabrication of units which lend themselves to be constructed together (and can be lifted) should be built in the Westwego Yard. Others in Category 3 would be constructed at Platens 8, 9, or 11. The latter would be chosen because of their relationship to the hull erection site (upriver or downriver).

UNIT CATEGORY 4 LARGE AND HEAVY THREE DIMENSIONAL MODULAR UNITS

These units are large and very heavy, with a long assembly period. They require piece-meal and close-tolerance fitting. Examples would be forepeak, aft peak and, in some cases, engine room double bottom. The assembly location would be Platen 10, 13, or Area 307, also chosen because of its relationship to the hull erection site. Fabrication for this category would be accomplished on Platen 16.

UNIT CATEGORY 5 MACHINERY SPACE DOUBLE BOTTOM

These units are typically those with the engine room innerbottom, as the base. The assembly period is long, with close-fitting tolerance, extensive outfitting and usually piece-mealed shell plate work. The units would be limited to 120 tons. Platen 14, just adjacent to the Plate Shop, would be the main and sub-assembly site. Platen 16 would produce the fabrication.

UNIT CATEGORY 6 SPECIAL WELDMENTS

These units are specialty items, such as rudders, skegs, anchor pockets, bilge keels, coamings, box girders, bulwarks, etc. Assembly will be done on Platen 19; fabrication (if required), from platen 16.

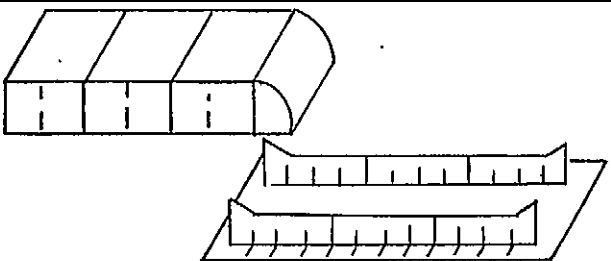
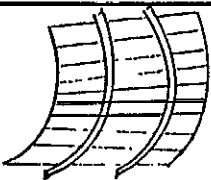
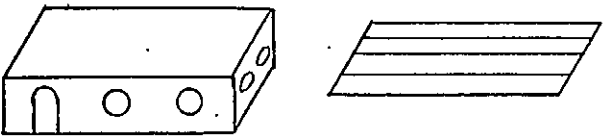
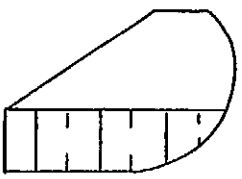
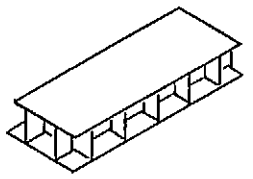
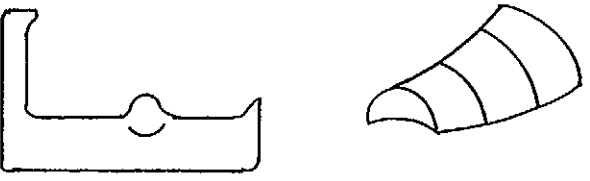
PARTIAL SUB UNIT CATEGORIES

Fabrication components are divided into nine (9) categories, based on their shape:

- 1) Floors
- 2) Girders
- 3) Webs, Long'l Bulkheads
- 4) Transverse Bulkheads
- 5) Built Up Beams
- 6) "L" Type Brackets
- 7) Walls (not produced on panel line)
- 8) Curtain or Margin Plates
- 9) Special Weldments (bilge keels, rudders,
anchor pockets, etc.)

As you can see by the types of unit categories and fabrication procedures, it is essential that efforts are geared toward unit categorization and the implementation of Process Lanes. The platens where each category of work is to be carried out, as well as fabrication platens, are shown graphically on the following page.

CATEGORY OF SUB-PLATENS & ASSEMBLY PLATENS

CATEGORY	UNIT NAME	PLATEN SUPPLYING FABRICATED PARTS	SHAPE	ASSEMBLY PLATEN
<p align="center">No. 1</p> <p>FLAT PANEL UNIT</p>	<p>MID PART DOUBLE BOTTOM SIDE SHELL LONG BHDS</p>	<p align="center">23</p> <p align="center">24</p>		<p align="center">20</p>
<p align="center">No. 2</p> <p>CURVED SHELL UNITS</p>	<p>AFT & FORE PART SIDE SHELLS</p>	<p align="center">16</p>		<p align="center">17</p>
<p align="center">No. 3</p> <p>SUPERSTRUCTURE UNITS</p>	<p>DECKS FLATS BULKHEADS HOUSES ETC.</p>	<p align="center">16</p>		<p align="center">8</p> <p align="center">9</p> <p align="center">11</p>
<p align="center">No. 4</p> <p>FORE PEAK AFT PEAK</p>	<p>LARGE AND HEAVY 3 DIMENSION UNITS</p>	<p align="center">16</p>		<p align="center">10</p> <p align="center">13</p> <p align="center">307</p>
<p align="center">No. 5</p> <p>ENGINE ROOM INNER BOTTOMS</p>	<p>LARGE AND HEAVY INTRICATE UNITS</p>	<p align="center">16</p>		<p align="center">14</p> <p align="center">307</p>
<p align="center">No. 6</p> <p>SPECIAL UNITS SKEGS RUDDERS ETC.</p>	<p>BULBOUS SHAPES STERN CASTINGS</p>	<p align="center">16</p>		<p align="center">19</p>

INDEX TO SECTION TWO: PHYSICAL PROCESS LANES

- 2.1 MAIN ASSEMBLY
- 2.2 FABRICATION
- 2.3 PRE-FABRICATION

2.1 PROCESS LANE MAIN ASSEMBLY

The selection of a main assembly work center depends on the volume of work to be produced which, in turn, gives the area required, based on the amount of work that can be produced daily. It also depends on other factors such as crane capacities and material flow.

Approximately one half of the units of a vessel will fall into Category 1. The other types collectively will comprise the other half. When selecting a sub-assembly and a fabrication site, we would consider the area where the main assembly work is to be done and the volume of work for each category. We should-also consider the material flow and the method of construction.

<u>Category</u>	<u>Main Assembly</u>	<u>Sub-Assembly</u>
(1)	Platen 20	Platen 20
(2)	Platen 17	Platen 17
(3)	Westwego Platens 2, 9, 11	Same
(4)	Platens 10, 13 Area 307	Same
(5)	Platen 14	Platen 14
(6)	Platen 19	Platen 19

PLATEN NO. 20

Platen 20 was selected for Type I units because of the work volume it can produce, and because of its relationship with the Panel Line and the material flow from Platens 23 and 24, making this the most suitable platen for Type 1 units.

There will be four designated construction stages on Platen 20. They are as follows:

Sub-Assembly with Storage
Pre-Outfitting with Storage
Main Assembly with Storage
Final Pre-Outfitting, Welding and
Inspection with Storage

The above establishes a specific location at the work center for sub-assembly and a specific location for main assembly and a specific location for pre-outfitting. This can be viewed graphically by reviewing system Sketch 10.5

The establishment of the four construction stages on Platen 20 will allow for the same kind of work to be done by the same people every day in that specific location where all of the work tools, welding machines, etc., needed for that work, are readily available. This concept is the automotive assembly line concept, whereby the work moves to the workers rather than having the workers relocate to the work, requiring the movement of all their special tooling.

The learning curve efficiency from this assembly line concept will provide lower manhour expenditures resulting in a management choice to decrease the manning at each stage and maintain current schedules, or to contract for more work. This is a fast moving area for easy-to-construct units.

Construction of Category No. 1 units on Platen 20 will parallel the following general pattern.

The base of the flat panel unit will be set and leveled in the sub-assembly stage where floors, girders, web frames, and bulkheads will be fitted and welded. The base panel will typically be a bottom shell, flat tank top, inboard longitudinal bulkhead, transverse centerline bulkhead, centerline main deck, or flat side shell. When all sub-assembly fitting and welding is completed, the sub-unit will be moved to the pre-outfitting stage.

The pre-outfitting stage will have a work queue storage of on-unit pallets for one (1) week's backlog of work. All outfitting crafts will pre-outfit the unit in this stage without disruption from the basic steel working crafts to the extent possible prior to closing in the unit. Upon completion of on-unit outfitting, the unit will move to the main assembly stage where final closing panels are fitted (where required) to form the main unit assembly.

Upon completion of this fitting work, the main assembly unit then moves to the "final" pre-outfitting, welding and inspection stage where the unit is turned over (when required) for final down hand welding, any additional on-unit outfitting that could not be accomplished in the pre-outfitting stage, customer inspection, and final pick-up work prior to blast and paint. The unit then moves to blast and paint prior to erection. By viewing the isometric drawing in Section 10.1, an understanding of the size, shape and the system for material handling-ease becomes clear for sequential work activity.

PLATEN NO. 17

It is recommended that an area be set aside for four pin jigs to accommodate maximum size Category No. 2 wing tank curved side shell units approximately 48 ft. by 52 ft. and two fixed jig areas for the same size units. There will be two areas set aside at the upriver end of the platen for a "buffer" and pre-outfitting stage and four sub-assembly/work queue areas set aside to support each of the pin jigs as well as one sub-assembly/work queue area to support the two fixed jigs.

Category No. 2 units are all curved side shell units requiring the use of curved side shell jigs, either the fixed or pin type depending on the degree of curvature. These units are, in general, more complex in construction requiring different construction methods and techniques and more elapsed time in assembly position than the Category No. 1 units. Therefore, since these units require a separate Process Lane apart from the faster moving

Category No. 1 units, Platen 17 is selected as being the most appropriate apart from Platen 20. Its location is convenient to the pre-fabrication shops for economical material flow and convenient to the blast and paint area upon completion of units. After units are removed from the jigs, they can proceed to the buffer/pre-outfit area of Platen 17 or straight to blast and paint.

Because the wing tank units for the upcoming Exxon Contract are so large and heavy (approximately 120 tons), additional mobile crane service or larger capacity bridge cranes on the platen will be required. (We recommend two (2) 75 ton bridge cranes.) The design and installation of a three (3) foot high flat platen construction jig the entire length of the platen is also required to support this heavier construction.

WESTWEGO & PLATENS 8, 9, 11

Category No. 3 units are the superstructure units, along with engine flats with bulkheads for side shell below. They consist of many different types of units, such as poop deck, navigation bridge deck, pilot house, machinery casing and boat deck.

Because Category No. 3 units are generally so large, a significantly large area will be designed for their construction. These units are typically those being built with a deck or a flat as the base of the unit. Such an example is the pilot house. The house top would be used as the base of the unit. Fit and weld miscellaneous bulkheads and exterior bulkhead to the base. There may be partial sub-assembly for this type of unit. After the fitting and welding is completed, the unit would be released for the pre-outfitting work and final inspection. Type 3 units will stay on the platen longer than most type one or two units because of their outfitting and piece-meal construction. Therefore, a separate Process Lane is required.

Platen 8, 9, 11 or Westwego yard was chosen as Process Lane No. 3 to build these type units with the fabrication of Platen 16 to support.

PLATENS 10, 13 AND AREA 307

Category No. 4 units consist of large and heavy modular units. which are difficult to build. Due to close fitting tolerances and some confined areas, they require, along with Category No. 5 units, the most qualified mechanics available. The units are usually piece meal with limited sub-assembly work. Type 4 units are fore and aft peaks, along with some engine room innerbottoms. These units are required to stay on the platen for a longer period than the Category 1, 2, and 3 types of units. Because of this, a separate Process Lane is required.

Platens 10, 13 and Area 307 will build these types of units with Platen 16 supplying the fabricated material.

The above platens were chosen because of their crane capacity and their relation to the erection site.

PLATEN NO. 14

Platen 14 was chosen to build Category No. 5 units because of the location to the Plate Shop with its Panel Line' and the material flow from Platen 16.

The work queue (backlog for the next week's work) is at the upriver end of the platen near the roadway separating Platen 14 from 17. Miscellaneous material coming from the pre-fabrication and fabrication stages will be stored here for sub and main assembly. A sub-assembly stage area separates the miscellaneous work queue from the panel work queue.

There are five (5) areas set aside for main assembly of five (5) engine room double bottom type units simultaneously, if required, along with area set aside at the downriver end of the platen as a buffer or unit outfitting area for two (2) additional units. At the extreme downriver end is a work queue/outfitting sub-assembly area.

A three (3) foot high flat platen construction jig for the length of the platen is required to support this construction.

Category No. 5 units are the engine room double bottoms. These units, along with the Category No. 4 units, will require longer construction time because of the complexity of close fitting tolerance, size, and outfitting work necessitating a separate Process Lane. We do not want to mix engine room double bottoms with flat panel units or curved side shell units.

PLATEN NO. 19

Platen 19 will have fixed jigs for fabrication of Category No. 6 units which includes fabrication and main assembly of bilge keel, bulwarks and hatch coamings. After completion, these units will be inspected and sent to the blast area for blasting and painting. This is no change from the current procedure.

The Physical Process Lane, as herein presented, will provide the anticipated material flow and learning curve efficiency to best suit the needs of this facility.

2.2 PROCESS LANE FABRICATION

There are. nine categories which are fabricated at Platens 23, 24 and 16. These categories are identified in the following manner.

- #1 - Floors, for Innerbottom
- #2 - Girders, for Innerbottom
- #3 - Webs, for Longitudinal Bulkhead, Side Shell & Centerline Deck Sections
- #4 - Stringers, for Transverse Bulkhead, Side Shell & Longitudinal Bulkhead
- #5 - Built Up Beams, Fabricated Built Up Beam on the Platens
- #6 - (L) Type, Fabrication of Brackets on the Platens
- #7 - Walls, Bulkhead & Flat Fabrication on the Platens
- #8 - Curtain and Margin Panels, that have to be Fabricated on the Platens
- #9 - Special Weldments (Bilge Keels, Rudders, Anchor Pockets, etc.)

These categories help to fully understand the size, shape and weight of each part that makes up a unit.

FABRICATION PLATEN NO. 23/24

Platen 23 will be the Process Lane for floors, girders, miscellaneous brackets. The platen will have a 14" high flat platen jig running for a length of 222 feet from the downriver end of the platen to facilitate' this constriction. The remaining 238 feet of platen will be used for turn-over welding and partial sub-assembly of floors to girders. Platen.24 will be primarily used for fabrication of web frames and horizontal stringers or girders. The platen will be set up with two (2)rows of 2-1/2 foot high tables, 450 feet long, to support the web frame fabrication line and a 14" high flat platen jig to support the construction of the horizontal stringer sections. The remaining portion of the platen will be

used for turn-over welding area and chipping/grinding. The area between the two platens is the work queue for both platens. Material from the pre-fabrication stages will be stored here for the next week's scheduled work.

At the extreme upriver end of both platens is a proposed 200 foot storage area which will be the work queue for Platen 20.

Upon completion of the fabrication of the partial sub units for Category No. 1 unit assemblies, they will be placed into transportation pallets and stored in this work queue area until the appropriate unit on Platen 20 is ready to receive.

FABRICATION PLATEN NO. 16

Platen 16 will fabricate for Category Type No. 2, 3, 4, and 5 units. For the fabrication of partial sub unit web frames for Category No. 2 units, there will be one table jig.

The size of this table jig will be 18 feet wide by 360 feet long and 2 feet 6 inches high. The fabrication on this table jig will consist of webs, stringers, and built-up members. Platen 16 will fabricate partial sub units for Category Type 3 units for Platens 8, 9, and 11. This construction will require one flat plate jig. The dimension of this jig will be 39 feet wide, 560 feet long, and 14 inches high. This plate jig will fabricate longitudinal bulkheads, transverse bulkheads, and miscellaneous flats.

Platen 16 will also fabricate partial sub units for Category No. 4 units on Platens 10, 13, and Area 307 using the same flat plate jig and jig table. The fabrication will consist of miscellaneous bulkheads, webs, stringers, horizontal girders for transverse bulkheads, and miscellaneous flats. Platen 16 will also fabricate to supply Category No. 5 units on Platen 14. The fabrication of partial sub units for centerline and outboard innerbottom units, such as floors, girders, docking brackets, and also partial sub-assembly of floors and docking brackets to longitudinal girders.

There will also be a turn-over jig for backside welding of webs. When the fabrication of these units is completed, **they will be** stored in transporting pallets.

At the extreme downriver end of the platen is the **work queue** for incoming material from the pre-fabricating stages **for the upcoming** week's schedule of work on Platen 16.

At the upriver end of the platen is **the work queue of completed** partial sub units awaiting assembly **at Platens 17, 8, 9, 10, 11,** or Area 307.

2.3 PROCESS LANE PRE-FABRICATION

Pre-fabrication is broken down into three (3) primary categories. They are:

- 1) Skin Plates: A - Straight (Cut Straight)
 B - Curved(Irregular Cuts)
- 2) Internal Members (Plate):
 A - Main Plates (N.C. Cut)
 B - Attached Plates (N.C., Servo, Shear, or Manual Cut)
- 3) Internal Members (Structural)
 A - "T" Beams
 B - Built-Up Beams
 C - A n g l e s
 D - Flat Bars
 E - Miscellaneous Others

The objective of the pre-fabrication shops is to cut and shape the hull parts to the exact size with the greatest accuracy possible to allow quick assembly and construction through the assigned work centers.

The objective in pre-fabrication is to minimize handling and movement of material and to work the same things in the same place which will create greater efficiency and reduce cost. The work methods of the various pre-fabrication operations need not be modified from existing methods; however, greater efficiency will be realized by the following recommended machinery arrangement.

1. Relocate frame bender, angle tool and punch press to Platen 18B to create an in-line structural operation.
2. Install N/C burning machine in Plate Shop in the area vacated by the frame bender. (This machine is currently at A.S.I. being warehoused.)
3. Develop line-forming station for formed plates where flat areas need forming.

PLATE SHOP

Plate Shop will receive 700 tons of raw steel plate per week to feed N.C. exacto and servo burning. This will cut floors, girders and miscellaneous brackets, longitudinal bulkhead, transverse bulkhead, side shell plate, and flats.

Some of these plates will go to another area in the shop to cut tabs or to rolls and bending machines; also, to go to Panel Line for fabrication. All material (except Panel Line material) will be separated and palletized in the shop and sent to the appropriate fabrication work queue.

PLATEN NO. 18

Platen 18 is to be designated as the structural steel pre-fabrication Process Lane. With this relocation of the punch press, frame and angle benders from the Plate Shop, the platen will process approximately 300 tons of structural steel per week.

Structurals will move from the downriver end of the platen toward the upriver end and, on completion of all cutting, punching and forming, will be palletized and sent to the appropriate fabrication stage work queues.

The "T" beam shop will continue to operate as in the past.

INDEX TO SECTION THREE: UNIT BREAKDOWN

3.1 WORK VOLUME AT EACH PRODUCTION STAGE

3.2 PROPOSED PLATEN LOADING

3.1 WORK VOLUME AT EACH PRODUCTION STAGE

As previously presented, we define what is meant by the term Process Lane. We spoke of the necessity of Process Lanes for an efficient production system and showed the need for assigning units into specific categories based on their physical characteristics. Remembering this, we will present the process required in developing A.S.I. total hull working amount of each stage as defined by the Process Lane terminology.

The document developed for accumulation of data for our chosen study sample (A.P.L. Contract) will be referred to as "Unit Category Summary Sheet" (Fig.1)

Several weeks research and fact accumulation was required by the committee gathering the necessary historical data and categorizing the A.P.L. Contract. Using the unit arrangement diagram with the unit summary and unit book list of material, the information for determining construction method, size, weight, and shape was derived. The unit was assigned to the appropriate Category one through six (Fig. 2) which, in turn, dictates the work location assigned and designed to accommodate the particular construction methods required for that category (Fig. 3). Work location and stage loading will be addressed later in the presentation. The next step was to further categorize each unit category into the categories for sub-assembly and fabrication using the same method as with unit categorization. Using the particular physical characteristics for determining the proper category of each assembly (Fig. 2) (Categorization Definition). Once categorization is accomplished, you can easily determine the steel hull weight to be produced at each Process Lane construction stage.

The percentage ratio of working amount at each stage will remain relatively constant from vessel to vessel depending upon the design of the typical mid-body. The larger the mid-body, the greater the demand for Category No. 1 hull weight requirements. The percent ratio may generally range from 40 to 65 percent with A.P.L. and Exxon being the extremes.

With the completion of the "Unit Category Summary Data Sheet" (Fig. 1), we now know the following information:

1. The number of units by type per category.
2. Total weight of units per category.
3. Average weight of units per category.
4. Total fitting length of units per category.
5. Average fitting length of units per category.
6. Total welding length of units per category.
7. Average welding length of units per category.

With this information, we factor the historical data of manhours actually spent for each operation at each stage. Also, the responsible area superintendent was consulted to verify the necessary manning and production time required at each stage. We are now able to derive the "Standard Work Day" of each type unit and total A.S.I. hull production operation.

With this data, we have the information necessary to platen load the production requirements of each work stage.

2B STANDARD WORK DAY

Using factual information as explained in developing the Unit Category Summary Sheet, the standard work day can be determined for each production stage.

In defining the standard work day, it is simply the total required hours which is total linear footage divided by the rate (feet per

hour) divided by the number of workmen that can be effectively worked on any given assembly at any stage, times the work hours per day.

A = Total Required Hour $A = B/C$ (formula)

B = Total Footage on Assembly 333 = 1000/3 (sample calculation)

C = Feet Per hour

D = Standard Work Day $D = \frac{A}{(Ext.)}$ (formula)

E = Number of Workmen

T = Hours Per Day 6.17 days = $\frac{333}{(6 \times 9)}$ (sample calculation)

This formula applied to each category stage gives us the standard work day.

CATEGORY RECAP SHEET

JOB NO. C1-15

FIG. 1

CATEGORY

TYPE SUB-ASSEMBLY

UNIT	WT.	WELD. LENG.	SIZE	BLAST PAINT	OUTFIT	ASSY	NO. FIT WEL	MAN- HOURS	NOTE
LBhd		22800			2	5	4 6	4500	5.1 FT/HR
TBhd		7920			2	5	2 3	2475	3.2 FT/HR
BS		4890			5	10	4 6	2250	4.3 FT/HR
TT		24224			5	10	4 6	9000	2.7 FT/HR
SS		15124			2	5	4 6	2700	5.6 FT/HR
TBhd		5040			2	5	2 3	1575	3.2 FT/HR
TBhd		1670			2	5	2 3	675	2.5 FT/HR
CBhd	378	4560		5	5	10	2 3	2025	2.3 FT/HR
BhdC	210	2256		5	2	5	2 3	675	3.3 FT/HR
UDC	974	3900		5	5	5	2 3	1125	3.5 FT/HR
BhdC		2056			2	5	2 3	900	2.3 FT/HR
SUB TOTAL	1562	94440						27900	2.4 FT/HR

FIG . 2
DEFINITIONS OF CATEGORIZING

MAIN ASSEMBLY:

- Category No. 1. Flat Panel Unit
No. 2. Curved Shell Unit
No. 3. Superstructure Unit or Semi-Flat Panel Unit
No. 4. Fore and Aft Peak Unit
No. 5 Engine Room Double Bottom' Unit
No. 6 Special Weldment Unit

SUB-ASSEMBLY:

- Category A. Floors to Girders on Tank Top
B. Webs, Decks, Bulkheads or Girders to Panels

FABRICATION:

- Category No. 1. Floors
No. 2. Girders
No. 3. Webs (for longitudinal bulkhead or shell)
No. 4. Stringer (for transverse bulkheads)
No. 5. Built Up Beams
No. 6 . "L" Type
No. 7. Walls
No. 8 . Curtain or Margin Plates
No. 9. Special Weldment (bilge keel, etc.)

PRE-FABRICATION :

- Category No. 1. Skin Plate
A - Straight Line Cut (exacto)
B - Shaped Irregular (n/c)
1. roll
2. roll and line heat
3. press
4. roll and black smith

FIG . 2
DEFINITIONS OF CATEGORIZING
(Continued)

PILE-FABRICATION :

Category No. 2. Internal Members

- A - Main Plate (n/c)
 - 1. roll
 - 2. roll and line heat
 - 3. press
 - 4. roll and black smith

No. 3. Structural

- A - Purchased "T" Beam
 - 1. straight
 - 2. curved
- B - Built Up Stiffener
 - 1. straight
 - 2. curved
- c - Purchased Angle
 - 1. straight
 - 2. curved
- D - Flat Bar
 - 1. straight
 - 2. curved
- E - Others
 - 1. straight
 - 2. curved

FIG. 3 - CATEGORIES

CATEGORY NO. 1

Process Lanes

	<u>Main Assy</u>	<u>Sub Assy</u>	<u>Partial Sub Assy</u>	<u>Pre-Fabrication</u>
Platen	20	20	23/24	various
Platen	20	20	Panel Line	various
Platen*	20	17	16	various
Platen*	20	17	Panel Line	various

CATEGORY NO. 2

Process Lanes

	<u>Main Assy</u>	<u>Sub Assy</u>	<u>Partial Sub Assy</u>	<u>Pre-Fabrication</u>
Platen*	17	17	16	various
Platen*	17	17	Panel Line	various

CATEGORY NO. 3

Process Lanes

	<u>Main Assy</u>	<u>Sub Assy</u>	<u>Partial Sub Assy</u>	<u>Pre-Fabrication</u>
Platen	8,9 or 11	8,9 or 11	16	various
Platen Vestwego Yd.				
platen *8, 9 or 11		17	16	various

CATEGORY NO. 4

-Process Lanes

	<u>Main Assy</u>	<u>Sub Assy</u>	<u>Partial Sub Assy</u>	<u>Pre-Fabrication</u>
Platen	10,13,307	10,13,307	16	various
Platen	*10,13,307	17	16	various

CATEGORY NO. 5

Process Lanes

	<u>Main Assy</u>	<u>Sub Assy</u>	<u>Partial Sub Assy</u>	<u>Pre-Fabrication</u>
Platen	14	1 4	16	various
Platen*	*14	17	16	various

CATEGORY NO. 6

Process Lanes

	<u>Main Assy</u>	<u>Sub Assy</u>	<u>Partial Sub Assy</u>	<u>Pre-Fabrication</u>
Platen	19	19	16	various

* Sub Assy on this stage might occur on rare occasions.

3.2 PROPOSED PLATEN LOADING

Proposed platen loading to support the Process Lane concept will be addressed with this section and will highlight the six (6) categories of construction and the platens most suited for each.

The study revolved around the production effort on Platen 20 and Platen 17 for the calendar year 1980 and the following recommendations for Process Lanes platen loading are based partially-on that history and partially on what must be produced to maintain the contractual key event dates for the upcoming contracts on hand.

The recommended tonnage for platen loading represents the average weekly erection tonnage (all jobs) for the calendar year 1980, as well as average assembly tonnage per week for each of the two platens.

The platens, that will be-discussed are:

Platen 20, Category No. 1 units, with Platen 23, 24 and Panel Line as supporting fabrication platens.

Platen 17, Category No. 2 units with Platen 16 and Panel Line as supporting fabrication platens.

Platen 14, Category No.5 units with Platen 16 and Panel Line as supporting fabrication platens.

Platen 20 is proposed to accommodate the Category No. 1 units (flat panel units), with the five (5) other categories, coming from other Process Lanes. Category No. 1 units are most typically comprised of Panel Line components. Examples would be double bottoms for a major portion of the mid-body; cofferdam bulkheads,

those wing tank units built on a flat longitudinal bulkhead, inboard and outboard wing tank sections, which would be built on flat longitudinal bulkhead or flat side shell.

The maximum weight would be approximately 140 tons per unit and approximately 48' x 52' in size. These dimensions are taken from the upcoming Exxon Contract (C1-15) because this work will be the first to flow through Process Lanes. These units comprise approximately 65% of the hull steel weight; therefore, a fast turnover of these units are required in order to meet key contract dates.

A review of Platen 20 loading for the duration of the Exxon Contract, based on the established preliminary key dates, indicates

_____ This should be approximately 600 tons per week (all jobs) of Category No. 1 units, which will approximate 6 to 8 units per week.

Actually, the number of units per week will be decided by their weight. These units represent approximately 60% of the total tons per week for erection. The remaining tonnage will come from the other Categories 2 through 6. Information collected and studied from past history (1980) supports 480 tons per week from Platen 20. By establishing Process Lanes as recommended by this committee, production should reach a level of 600 tons per week from Platen 20, with little difficulty.

The quantity of units per week (based on their weights) can then be determined, and this establishes the number of units per week (Category No. 1) that will be available for erection during any given week from keel laying to launch from Platen 20. The number of units per week is established (including units in the other categories) and is now applied to the unit erection sequence, then the erection schedule can be established.

PLATEN NO. 20

Platen 20 (Category No. 1 units) should be producing 600 tons per week, which will be supported by the following:

- 1) Plate Shop and Panel Line will supply approximately 420 tons per week.
- 2) Platens 23 and 24 will supply approximately 180 tons per week.

When Platens 23 and 24 are fully loaded, they can hold 400 tons.

Platen 23 will fabricate the following:

- A) Floors
- B) Girders
- C) Docking Bracket & Misc. Brackets
- D) Partial Sub-Unit Completion (Floors to Girders)

Platen 24 will fabricate the following:

- A) Web Frames for -
 - Longitudinal Bulkheads
 - Side Shell
 - Main Deck C1 Section
- B) Horizontal Stringers
- C) Partial Webs

It is important to note that the quantity of Category No. 1 units per week to be erected (all jobs) must not exceed the maximum tonnage of 600 tons output per week from Platen 20. In other words, in the beginning there should not be more, or less, than the approximate 600 tons of work scheduled in any one (1) week for Platen 20. As we gain experience and efficiency, the tonnage should increase.

PLATEN NO. 17

Platen 17 will accommodate Category No. 2 units (curved side shell units). These are units that use the curved side shell as the base of the unit and are constructed in jigs. At the present time, for the Exxon Contract, there will be four (4) pin jigs located on Platen 17, along with several fixed jigs. Examples would be wing tanks, outboard section of wings, some sub-assemblies for other categories.

minimum weight of these units would be approximately 120 tons and approximate dimensions of 48'x 52'. The units should be located as close to the roadway as possible. The reason for this is that, due to the weight, mobile cranes or additional overhead crane capacity will be needed to remove units from platen.

Platen 17 was chosen for Category No. 2 units as the most appropriate sub-assembly and main assembly site due to the relatively short distance from the Panel Line. Category No. 2 fabrication will be accomplished on Platen 16 and Panel Line. Platen 17 will be required to furnish one (1) unit approximately 120 tons per week in order to support the required tonnage for erection per week for the Exxon Contract. The above information was based on 1980 statistics, whereas Platen 17 produced two (2) 60 ton units per week.

PLATEN NO. 14

Platen 14 will accommodate Category No. 5 units (machinery space double bottoms). These units are typically built with the engine room tank top as the base of the units. The construction period is long term due to the assembly complexities of close fitting tolerances and the outfitting work. These units would be limited to approximately 120 tons.

Platen 14 was chosen for Category No. 5 units as the most appropriate sub-assembly and main assembly site due to the fact that some of the work would come from the adjacent Pre-Fabrication work centers and Panel Line. Platen 16 and Panel Line would be the fabrication sites. Platen 14 would be required to furnish one (1) unit per week for the Exxon Contract to support the erection schedule in the beginning.

The remaining Categories 3, 4 and 6 will be produced at Platens 8, 9, 10, 11, 19 and Westwego. These categories will be required to produce approximately 140 tons per week in keeping with a total output of approximately 1000 tons per week for all jobs.

To recap the average tonnage output for **Process Lanes**, the following applies:

- 1) Category No. 1 - 600 tons **per week**
- 2) Category No. 2 - 140 tons **per week**
- 3) Category No. 5 - 120 tons **per week**
- 4) **Category No. 3, 4, 6 - 140 tons per week**
 1000 tons per week

Another very important point of Process Lanes planning is the leveling of the. amount of work for each stage. In other words, the assembly rotation period of each unit on each stage should be as equal as possible. Units will then shift from work center to work center with a smooth flow and no idle time. This leveling can be scheduled through use of the standard and actual work day data.

INDEX TO SECTION FOUR: MATERIAL FLOW

4.1 MATERIAL FLOW AND FACILITY
LAYOUT ANALYSIS

4.1 MATERIAL FLOW AND FACILITY LAYOUT ANALYSIS

The' basic concept of good plant layout is effective material flow. The objective is to minimize the number and length of routes and eliminate any unnecessary movements such as backhauls, cross-hauls, transfers, etc. Material flow problems can arise because of changes in the design of a process or may develop because of gradual changes over time that finally manifest themselves in terms of bottlenecks in production, crowded conditions, poor housekeeping, failure to meet schedules, and a high ratio of material handling time to production time.

The material flow analysis, which was performed at Avondale, concentrates on some quantitative measure of movement between departments or activities. Since the shipyard layout should be designed to facilitate the flow of the product, we are primarily concerned with the flow of materials. Some of the factors that affect material flow are:

1. External transportation facilities.
2. The number of items to be moved.
3. The number of units to be produced.
4. Material storage locations.
5. Location of manufacturing service areas.

The most popular method of analyzing material flow is to use charts and diagrams. The flow diagram and the "From - To" chart was employed to analyze the material flow of Avondale Shipyards. The flow diagram is an illustration of the actual-flow of material and is quite beneficial in evaluating present or proposed facility layouts. From the flow diagram, we can measure-material-handling distances.

The development of the charts and diagrams presented in this analysis were generated from information collected during a ten week period in March, April and May of 1981. The information was extracted from reports derived by the Material Control Department and mobile crane servicing area. These reports represented actual material movements within the shipyard. The information was summarized and is presented here in the form of the present material flow diagrams and present method's "From - To" charts. The "From - To" charts were developed representing a measure of the steel material flow between work areas. These "From - To" charts provide information concerning the number of materialhandling trips made between centers of activities, the volume of material moved between centers of activities, and the total material-handling distances. A sample "From - To" chart is provided in Section 10.2.

Using information developed by the Process Lanes Committee concerning future work locations and working with the present method's "From - To" charts, the proposed flow diagrams were developed. Sample diagrams showing the present and proposed flow are provided in Sections 10.3 and 10.4. The proposed flow method was developed by keeping in mind the Process Lanes concept of eliminating multi-hull cutting and the concept of work site storage queues. The "From - To" charts of the proposed method have incorporated present production rates for ease of analysis.

Since the Process Lanes concept will eliminate steel material flow (except outfitting) to the fabrication storage area and direct this material to work site storage queues, proposed "From - 'To" charts were developed by mathematically shifting related material from the fabrication storage area to the work site storage queues. The end result will be a large reduction in material going to fabrication storage, A-crane (rack) storage, and structural bulk storage from the Plate Shop and Platen 18, and an appropriate increase in material going to the work sites from the Plate Shop and Platen 18.

The "From - To" charts show that under the present facility layout and storage method we move-9,174 pieces of steel material per week, of which 60.7% is moved to or from the fabrication storage area. The proposed Process Lanes method will move 6,571 pieces per week of which 8% will move-to or from the fabrication storage area. The reduction-of 2,603 pieces per week will be due to the large reduction in double handling due to eliminating much of the material movement to the fabrication storage area. A projected reduction of 28.4% in the number of pieces handled per week may be realized by the Process Lanes concept.

Presently, we make 170.5 trips per week moving an average of 53.8 pieces per trip of which 47.8% is moved to or from the fabrication storage area. The Process Lanes method will make 145.2 trips per week moving an average of 45.3 pieces per trip of which 6.4% will move to or from the fabrication storage area. A 14.8% reduction in the number of trips per week will be realized while handling 15.8% less material per trip. If we fill the loads to capacity (assume 53.8 pieces/load is capacity), we will reduce the trips by an additional 15.8% and project a total reduction of 30.6% on the total number of trips per week. Table 2 is a summary of the hull steel material movement present and proposed by pieces.

The present facility layout has a total steel material movement of 66.6 (in plant) miles per week of which 60% is to and from the fabrication storage area. Under the proposed Process Lanes method, movement will be 43.4 miles per week of which 13.6% will be to and from the fabrication storage area. A projected reduction of 23.2 miles per week (34.8%) may be realized under the Process Lanes concept.

There are 177 distinct moves from area to area under the present material flow method. Under the Process Lanes method, there will be a reduction of these moves by 58 for a total of 119 resulting in a 32.8% decrease in the number of distinct moves. Table 1 is a summary of the hull steel material movement present and proposed by trips.

Evaluating these four areas, it can be projected that a savings of approximately 30% in the handling of steel material will be realized due to the implementation of the Process Lanes concept. The appropriate cost savings can be obtained by evaluating the manpower, equipment, and energy reductions which will result from a 30% reduction in the handling of steel material. It has become evident from the analysis that a major reason for Process Lanes implementation is the need for the evolution of an ideal material handling and flow system.

HULL STEEL
MATERIAL MOVEMENT
COMPARISON
BY TRIPS AND DISTANCE

TABLE 1

Material Handling Distance/week (Miles)	PRESENT METHOD	PROCESS LANES	DIFFERENCE
	66.6	43.4	23.2
Material Handling Distance To-From Fab. Storage	39.3	5.9	33.4
Percent M.H. Distance To-From Fab. Storage	60.0	13.6	
Trips/week from Plate Shop	42.3	62.3	(20.0)
Trips/week from Platen 18	5.3	11.4	(6.1)
Trips/week from A-Crane Storage	31.3	7.7	23.6
Distinct Moves	177	119	58

HULL STEEL
MATERIAL MOVEMENT
COMPARISON
BY PIECES

TABLE 2

DESCRIPTION	PRESENT METHOD	PROCESS LANES	DIFFERENCE
Pieces/week	9,174	6,571	2,603
Pieces To-From Fabrication Storage	5,564	532	5,032
Percent To-From Fabrication Storage	60.7	8.0	
Trips/week	170.5	145.2	25.3
Pieces/trip	53.8	45.3	8.5
Trips/week To-From Fabrication Storage	81.5	9.3	72.2
Percent To-From Fabrication Storage	47.8	6.4	

INDEX TO SECTION FIVE: CODING SYSTEM

5.1 PIECE CODING

5.2 COST CODING

5.3 COST CODE DEFINITION

5.1 PIECE CODING

The primary" purpose of piece codings is to identify material to be used to make any given portion of the hull. Process Lanes has broken unit construction down into four (4) categories:

1. Main Assembly
2. Sub-Assembly
3. Fabrication (Partial Sub-Assembly)
4. Pre-Fabrication

In order to provide continuity within the total system, the piece coding should be compatible with Process Lanes concept. Therefore, the piece code should represent the construction processes a particular piece will encounter. So, we now have a four (4) section piece code as shown below:

Main Assembly	Sub-Assembly	Fabrication	Pre-Fabrication
0 0 0	0 0 0	000	0 0 0
Unit	Sub - Unit	P.S.U.	Piece

Due to different construction methods for units, some pieces may not follow all four (4) steps, but may skip processes. Examples are shown below:

101-00-00-001 - Piece goes from Pre-Fab straight to
Main Assembly.

101-00-03-002 & 003 - Partial sub-unit" skips Sub-Assembly
process.

It is, however, very important to indicate-each of the four (4) steps due to the fact that it indicates the work processes. The composition of piece coding is dictated by where the work is to be

completed. There are some cases where the type of work could be considered either fabrication or sub-assembly. To be compatible with Process Lanes, the work location would dictate the piece code. An example is as follows:

101-21-00-001 - Sub Unit 1 is curved shell, piece 001 is fit
loose at Platen 17
101-21-81-002 & 003 - PSU 81 is blanket from Panel Line
101-21-00-001, 002 & 003 - All pieces are fit loose on jig at
Platen 17

The key in keeping the piece coding in line with Process Lanes is the unit number. A further study of this number shows it to be a very useful tool.

The unit number is a three digit code. The first digit indicates the main assembly unit category. So, it would be 1, 2, 3, 4, 5, or 6.

The second and third digits indicate the scheduled order of working those units within a category or Process Lanes. Therefore, the unit would indicate, because of Process Lanes, the main assembly site, the sub-assembly site, the fabrication site and the sequence of main assembly for each Process Lane. Because the unit number gives the assembly site and sequence, it becomes a very useful tool in scheduling sub-assembly, fabrication, pre-fabrication and all the way back through procurement of raw materials. This number serves as the catalyst for the "COPICS" program to schedule work for all work centers from contract through erection. It is also the key for shipping material. If we know the piece code, then we also know the route that the material must take. Examples are as follows:

101-11-01-001 - Piece 001 goes to Platen 24
222-21-01-003 - Piece 003 goes to platen 16
103-000-000-032 - Piece 032 goes to Platen 20

The sorting of material to a work center becomes a very simple matter. This is also important when Loading a work center.

Within Process Lanes there are circumstances where sub-assembly work would be accomplished at the sub-assembly site of another unit category. So, therefore, in order to provide continuity within the system, we should indicate the sub-assembly location in the piece code. This would be indicated by 1, 2, 3, 4, 5, or 6 as the second digit. The third digit would be a sequential number. It is highly improbable that the number of-sub-assemblies within a unit would be more than 9.

The fabrication site is pre-determined by the main assembly and sub-assembly site.

The Panel Line Operation, whose end product is partial sub-assembly, feeds all main and sub-assembly categories. So, therefore, the work to be done at that stage would be identified. This is done by simply having the second digit as 8 in the PSU number. The third digit would be a sequential number.

Now we should consider those items going straight to erection from the piece, partial sub-unit and sub-unit level. This is accomplished by simply showing the digit 9 as the first of 3 digits at the piece, PSU and SU level of the piece code. Examples are listed as follows:

1. Piece going through all 4 stages

101-11-01-001

20-20-24-P.F.

- 2 Piece going through all 4 stages - sub-assembly done
elsewhere

101-21-01-001

20-17-16-P.F.

3. Piece going through all 4 stages - fab in Panel Line
101-11-81-001
20-20-P.L.-P.F.
4. Piece skipping fab Stage going to sub-assembly
101-11-00-001
20-20----P.F.
5. Piece skipping fab and sub-assembly
101-00-00-001
20-----P.F.
6. Piece going straight to erection
101-00-00-901
-----erection
7. P.S.U. going straight to erection
101-00-911-001
erection-24-P.F.
8. P.S.U. (Panel Line) going straight to erection
101-00-981-001
erection-P.L.-P.F.
9. S.U. going straight to erection
101-911-00-001
erection-Platen 20-P.F.

5.2 COST CODING

The primary purpose of cost coding is to retrieve cost data for work centers and, thus, efficiency and collect costs for future bidding. Therefore, it is very important that cost collection be accurate and useable. Process Lanes has identified work centers by type of construction so, therefore, it has also identified the cost centers. Cost would be collected and allocated by manhours per ton of steel produced at each of the cost centers. Since the cost center is also a particular type of work center, we can determine the production cost of any of the four (4) production processes, main assembly, fabrication, and pre-fabrication for any of the six (6) unit types. This would be especially helpful in future bidding. Below is a system of cost coding that is compatible with both Process Lanes and piece coding.

First two digits will be "02" which indicates hull construction as opposed to outfitting.

The second two digits indicate the operation to take place. They would be:

- 01 - Pre-Fabrication
- 02 - Fabrication
- 03 - Sub-Assembly
- 04 - Main Assembly

The third two digits indicate both the location and the type of work to be done.

The first digit is the location:

- 1 - Platen
- 2 - Platen 17
- 3 - Platen 8, 9, 11
- 4 - Platen 10, 13, Area 307 Main Assembly

5 - Platen 14

6 - Platen 19

1 - Platen 20

2 - Platen 17

3 - Platen 8, 9, 11

4 - Platen 10, 13, Area 307 Sub-Assembly

5 - Platen 14

6 - Platen 19

1 - Platen 24/23

2 - Platen 16 Fabrication

1 - Burning

2 - Forming Pre-Fabrication

The second digit would indicate the type of work to be done:

1 - Fitting

2 - Welding

3 - Clean-Up Main Assembly

4 - Other

1 - Fitting

2 - Welding

3 - Clean-Up Sub-Assembly

4 - Other

1 - Fitting

2 - Welding

3 - Clean-Up Fabrication

4 - Other

1 - 3 Axis N.C.

2 - 2 Axis N.C.

3 - Manual Burn (Plate)

4 - Servo

5 - Exacto Burning
6 - Travo
7 - Finishing Work
8 - Manual Burn Structural
9 - Shear

Pre-Fabrication

1 - Roll (Plate)
2 - Line Heating (Plate)
3 - Press
4 - Cold Form (Structural)
5 - Line Heat (Structural)
6 - Punch

Forming

5.3 COST CODE DEFINITION

02-04-11 Hull Construction, Main Assembly, Platen 20, Shipfitting
02-01-11 Hull Construction, Pre-Fabrication, Burning, 3 Axis N.C.
02-02-12 Hull Construction, Fabrication, Platen 24, Welding

This is not intended to be a complete listing of cost codes. It is intended to show how cost should be collected in order to obtain the work efficiencies of the various Process Lanes.

We have managed to have the major sub-systems in line with another which established a workable and useful production system using process Lanes, piece coding and cost coding. The door is now open to use the system to plan, schedule, and cost which will make a more efficient hull production process.

INDEX TO SECTION SIX: SCHEDULE PLANNING FOR HULL CONSTRUCTION

6.1 TOTAL CONTRACT REQUIREMENTS

6.2 FACILITY CAPACITY LOADING

6.1 TOTAL CONTRACT REQUIREMENTS

Too often, the relative importance of scheduling the support functions of the production effort is misunderstood. Quite simply, the performance of those functions in terms of timeliness and accuracy has a direct and powerful impact on the timeliness and accuracy of the production effort. Therefore, the control and monitoring of these operations should be accomplished with the same degree of attention given to the blue collar sector of the company.

With the advent of Process Lanes in hull construction, efforts should be taken to develop a "Process Lane," so to speak, for the planning effort required prior to hull construction.

This is satisfactorily accomplished by keeping in mind that its development and mission is that of support to the production policy, i.e. Process Lanes.

This method, as with any method of planning in order to be effective, requires a well organized planning nucleus-with standard operating-practices to supply all production and production related departments with the directives and information necessary to start and complete any given job as required by the contract and in compliance with the production policy.

There are certain requirements necessary from Planning, beginning with the preparation of information for bids on new contracts. Planning must confirm compatibility of proposed key dates of new contracts based on continually monitored data concerning production capacity of each production stage. A system of continual

monitoring of schedule status and cost readily gives management the information required to more accurately bid new jobs and deliver as contracted.

Once a contract is awarded, it is essential that the planning operations perform continuing functions in an orderly time phased operation to allow every supporting operation the required lead time which enables them (Marketing, Engineering, Purchasing, Mold Loft and Production Planning) adequate time to develop schedules compatible to support construction requirements.

It is not enough just to establish and monitor the requirements of the construction stages, but establish systems of control for all support sections of the company. For if this control does not exist, no system can expect to achieve the increased efficiency as planned with the Process Lanes concept.

The overall system must interface and each division must carry out their part of the plan. For if this is not controlled, the impact of late and out of sequence information is dropped entirely on the shoulders of production, creating a log jam which makes it very difficult to meet schedule and escalates greatly the construction cost and overloads the facilities. It also causes crisis management situations and impacts the production flow. As seen in schedule chart, Fig. (4), an interface occurs and the lead times exist to allow the supporting areas to complete and process information through the system.

The company hull loading chart is developed from rough hull weight and by using this information, it is easy to level load the facility and determine what type and when new contracts can be accepted.

6.2 FACILITY CAPACITY LOADING

Based on the main yard assembly capacity of 4,200 short tons per month, a total of 35,500 tons of work may be accepted and launched during the period January 1982 and March 1983.

This information becomes evident when the work currently in progress and known future work is plotted according to key events of those contracts, using the erection tonnage. It is important to note that when scheduling multiple contracts or multi-hull contracts, consideration must be given to the projected erection sequence and category of units to be erected on the hulls concerned.

The objective here is to prevent the overloading of assembly work centers, which is the control point of hull construction, while remaining as close to the assembly capacity of 4,200 tons as possible.

5 DAY WEEKS
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51.

PRODUCTION REQUIREMENTS

PPE FAB

ENG. DWG.

PROD. ENG.
WORK ORDER

MATL.
ALLOCATION

UCM - MOLD.

DWGS. ISSUE

Δ Δ PF

Δ Δ PF ISSUE WO

STEEL TRANSFER

MOLD LOFT ISSUE

CONTRACT
DWGS.

AFY DATES
BID DATA

AWARD

HULL BRKDN.
ER. SEQ. TO RS

ENG. UNIT DW.
SCHED. - ISSU

ENG. MAT'L
SUM. + SCHED

PURCHASE
MATERIAL

SUMMARY UNIT

WEIGHT
CALCULATION

CATEGORIZE
UNITS

PRESENT WORK
STAGE LOAD

ESTABLISH
PRE-T. SCHED.

NEW WORK

PLANNING REQUIREMENTS

②

②

③

①

②

③

③

④

⑤

②

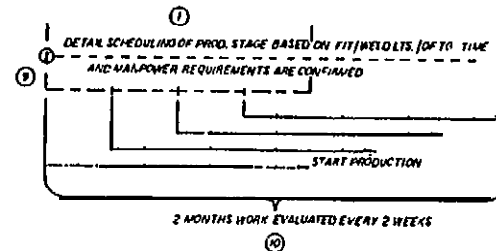
ROUGH STAGE - A/S A/F, OF
LOAD TO CAPACITY BASED ON TONNAGE

②

③ INSURE COMPATIBILITY WITH
KEY DATES

ROUGH LOAD
FOR BID INFO
BASED ON VESSEL
CLASS UNITON

○ MARKETING INFORMATION
VARD LOADING, AVAILABLE
TIME AND SPACE



INDEX TO SECTION SEVEN: CONTROL SYSTEMS

7.1 PLANNING CONTROL UNDER PROCESS
LANES CONCEPTS

7.2 PROCESS AND EFFICIENCY CONTROL

7.3 STAGE PLANS

7.1 PLANNING CONTROL UNDER PROCESS LANES CONCEPT

With the implementation of Process Lanes on future contracts, the Planning Engineering Department will be-required to study, platen load, and schedule within. Process Lanes guidelines to insure realistic achievable schedules.

These following Guidelines are thus established and should be scheduled within the Planning Department in the proper sequence upon inquiries for new contracts.

1. Determine Present Platen Loading
2. Establish Key Dates
3. Divide Hull into Units and Develop Erection Sequence
4. Categorize Hull Units
5. Weight Calculations by Unit (rough)
6. Platen Load (Platen 20) to Capacity
7. Establish the Erection Schedule
8. Insure Compatibility with Key_Dates
9. Prepare Ground Assembly Schedule
10. As Detailed Drawings Become Available
Refine Weight Estimates and All Schedules

Summaries of the planning effort required for each of the above Guidelines are explained as follows:

1. DETERMINE PRESENT PLATEN LOADING

Study the present and long term loading for contracts in progress on Platen 20 and Platen 17. This should be constantly monitored and the loading for any given week should be immediately available for each Platen and all contracts on hand for the period of their duration. A large scale plywood model of Platens 17 and 20 would

be desirable for placing template paper scale models for each unit (each week) in progress on the Platens for easy monitoring by the Planning Engineer.

2. ESTABLISH KEY DATES

The Planning Department must establish the possible key event dates (start pre-fabrication, keel, launch and delivery) as soon as possible based on the required delivery date set by the *customer* and within the overall master (long term) yard schedule. This effort must be "rough cut" or preliminary for contract bid purposes and then refined upon signing of contract (or letter of intent).

3. DIVIDE HULL INTO UNITS AND DEVELOP ERECTION SEQUENCE

The unit arrangement drawing must be prepared for purposes of unit dividing and numbering and the development of desired erection sequence. The list of units, along with basic unit descriptions, should be prepared.

4. CATEGORIZE HULL UNITS

The hull units are to be categorized within the Process Lanes concept and a separate list of units should then be prepared within each of the six (6) Process Lanes categories, along with basic unit descriptions and weights (to be added later). The Planning Engineer should study the construction method of each unit and determine the proper category in which to place the unit.

5. WEIGHT CALCULATIONS

Weight estimates must be done for each unit in Category No. 1 and Category No. 2 for purposes of proper platen loading on Platen 20 (Process Lane No. 1) and Platen 17 (Process Lane No. 2).

6. PLATEN LOAD PLATEN 20 TO CAPACITY

After thoroughly reviewing the loading of Platen 20 (Guideline No. 1) for the period of time of the duration of NEW contract based on the established preliminary key event dates, the platen

should then be loaded (week by week) to-capacity. (For the first vessel of the C1-15 Exxon contract this should be 600 short tons per week.) THE QUANTITY OF UNITS PER WEEK (BASED ON THEIR WEIGHTS) CAN THEN BE DETERMINED and this then establishes the NUMBER of units per week that will be available for erection during any given week from start to launch from Platen 20. The number of units per week now established is then applied to the unit erection sequence (Guideline No. 3) and the erection schedule can be established.

7. ESTABLISH ERECTION SCHEDULE

Using the sequence of erection developed in Guideline No. 3 and the number of units per week available from Platen 20 developed in Guideline No. 6, the erection schedule can be developed. For example, if the first 5 units to be erected are numbered in sequence No. 1, No. 2, No. 3, No. 4 and No. 5 and the unit weights are:

Unit No.1	=	86.5-tons
Unit No.2	=	125.0 tons
Unit No. 3	=	125.0 tons
Unit No. 4	=	86.5 tons
Unit No. 5	=	<u>86.5</u> tons
Total	=	509.5 tons

then Units No. 1 through No. 5 can be erected in one (1) week leaving $600 - 509.5 = 90.5$ tons (based on 600 tons/week output Platen 20) available for units on another ship.

IT IS IMPORTANT TO NOTE THAT THE QUANTITY 'OF CATEGORY NO. 1 UNITS PER WEEK TO BE ERECTED (ALL JOBS) CANNOT EXCEED THIS MAXIMUM TONNAGE OUTPUT PER WEEK AVAILABLE FROM PLATEN 20.

8. INSURE COMPATIBILITY WITH KEY DATES

Review the prepared erection schedule to be sure that all units can be erected in a timely fashion with the rough draft key event

dates established in Guideline No. 2 and consistent with machinery requirements. Adjustments to platen loading (Guideline No. 6) should be made if required.

9. PREPARE GROUND ASSEMBLY SCHEDULE

The ground assembly or platen loading schedule should be prepared as a two (2) month schedule , updated and issued once a month for all platens.

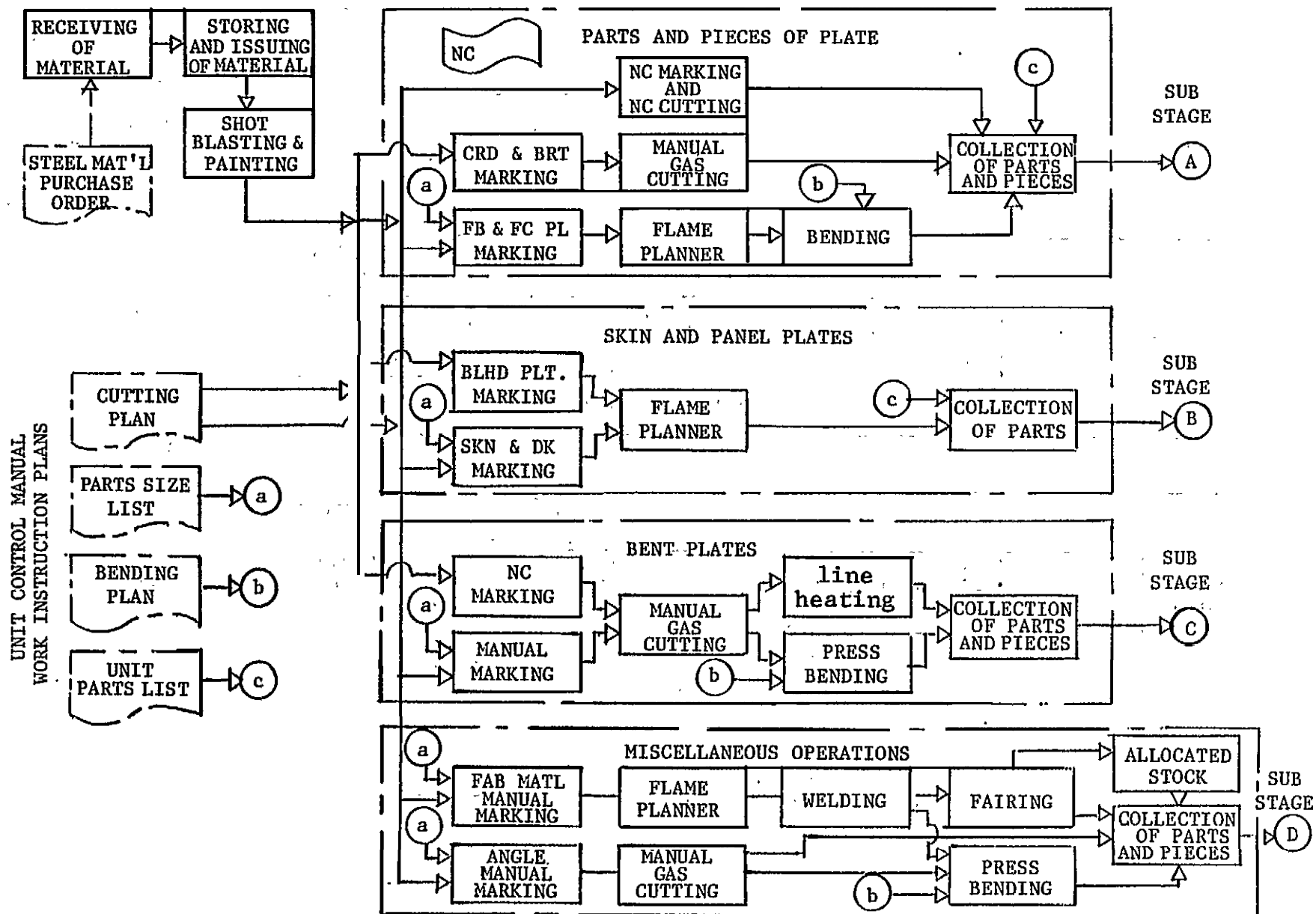
10. DETAILED DRAWINGS - REFINE SCHEDULES

As detailed drawings are developed and become available, a review of all weight estimates is necessary, and fitting and welding lengths may be used as desired to further refine and update all platen loading schedules.

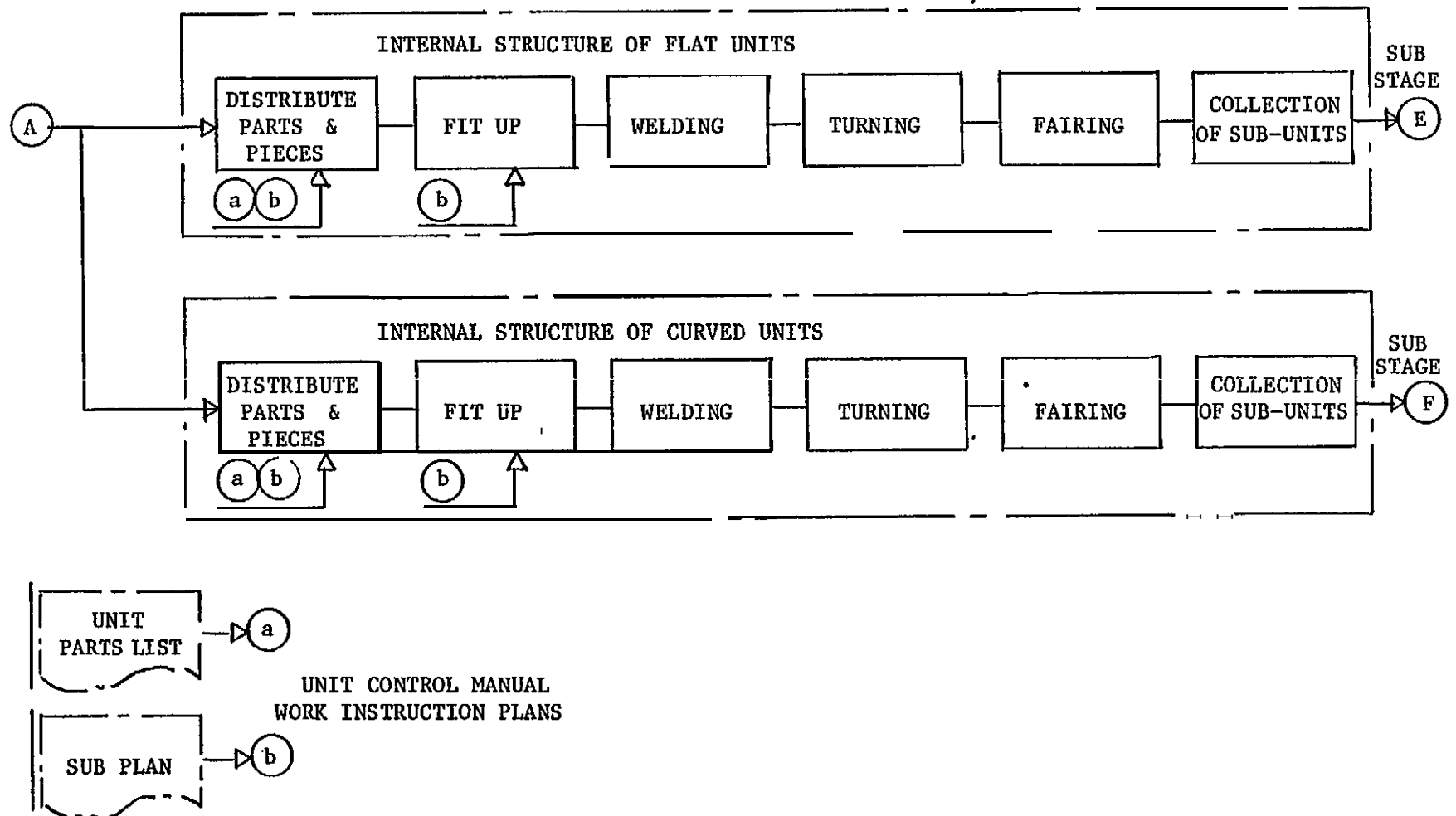
11. PLANNING FLOW DIAGRAMS

The lead Hull Planner starts writing his construction method instructions in great detail assigning partial sub-assemblies, sub-assemblies, and main assemblies to the specific Process Lanes. This information flow "working instruction," as well as the Process Lanes flow, is shown graphically within the following four (4) flow charts.

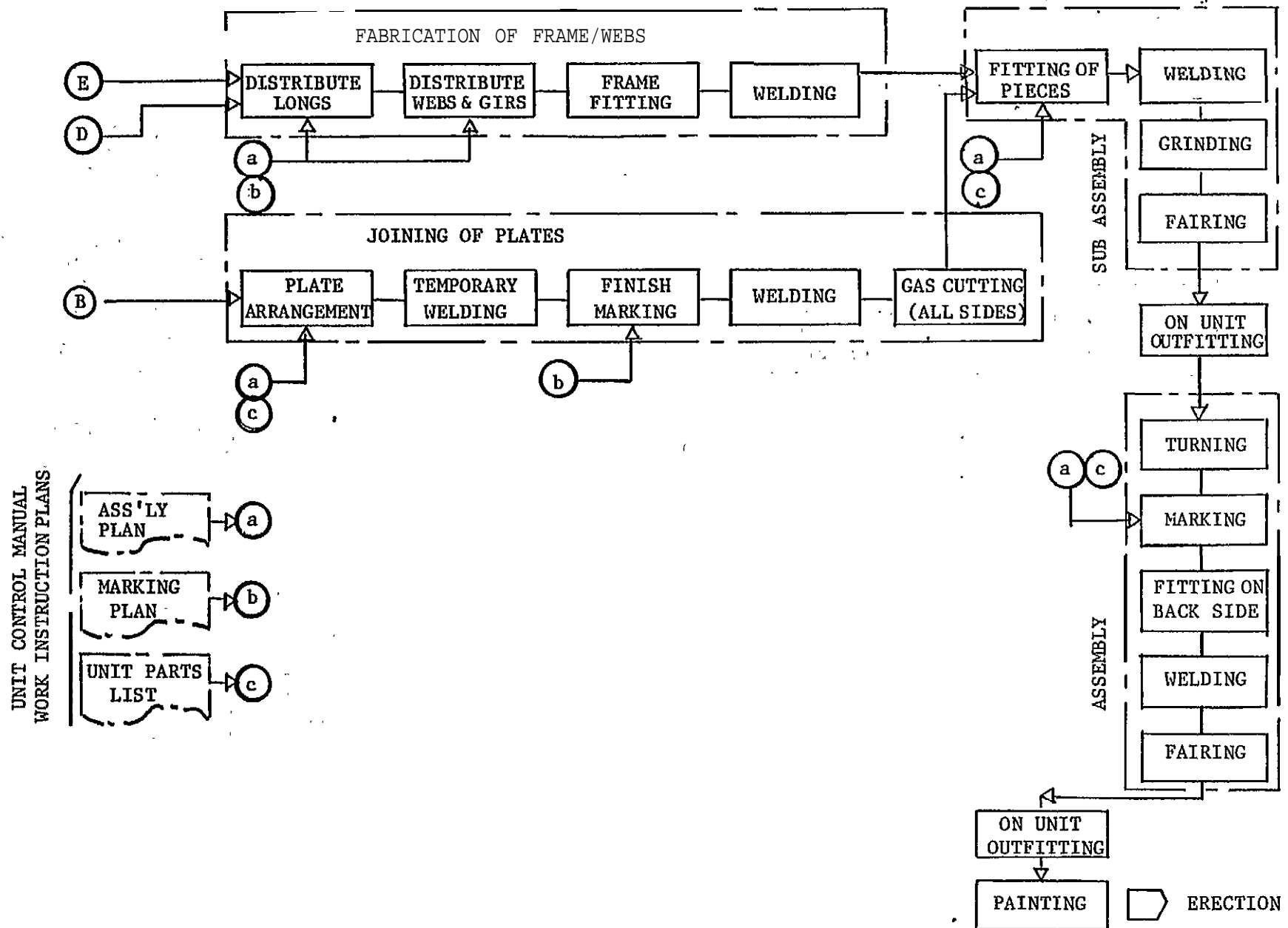
PROCESS LANES FLOW FOR THE PREFABRICATION STAGE
AND WORKING INSTRUCTION PLANS



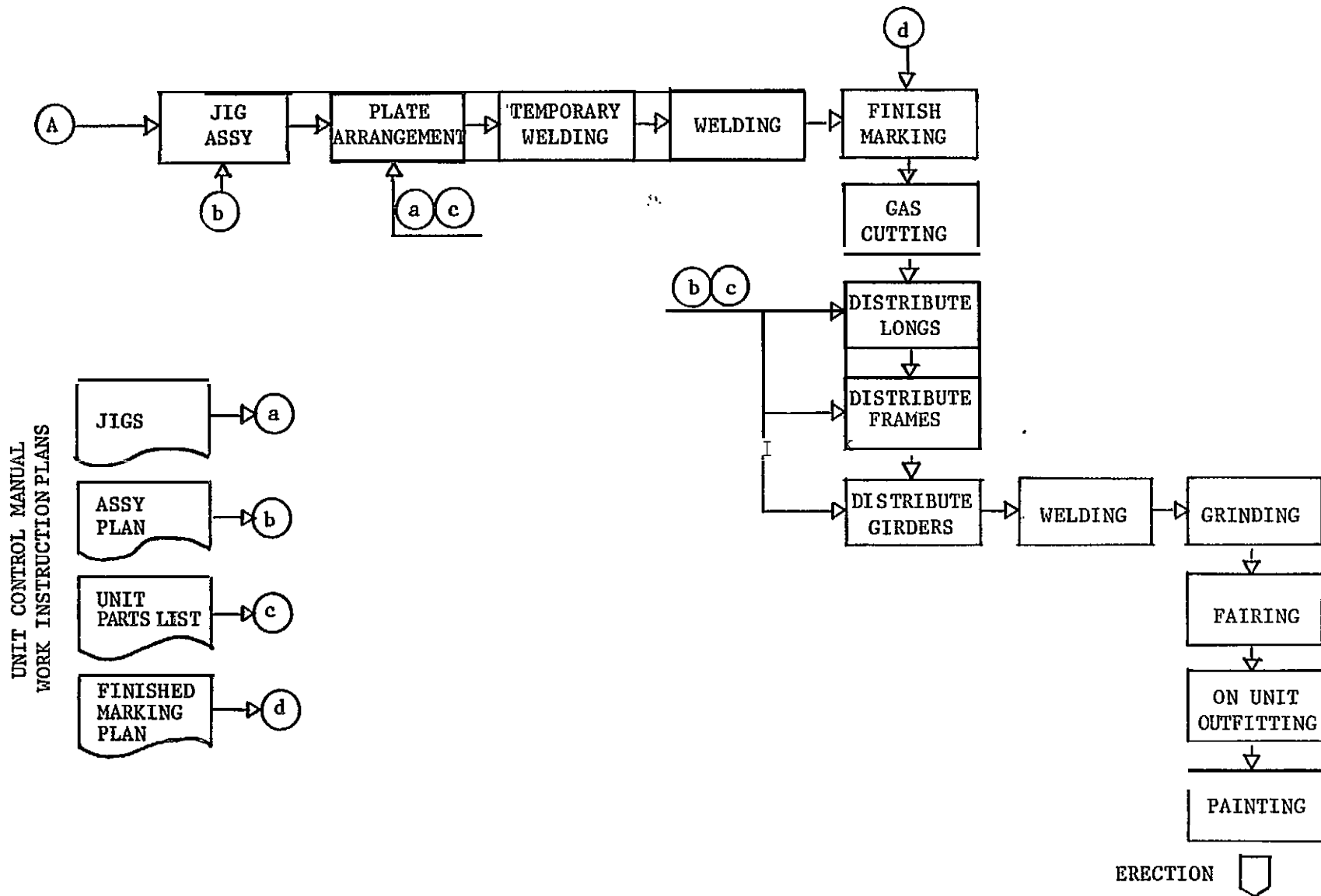
PROCESS LANES FLOW FOR THE SUB-ASSEMBLY STAGE AND WORKING INSTRUCTION PLANS



-62-



PROCESS LANES FLOW FOR THE ASSEMBLY STAGE (CURVED
UNITS) AND WORKING INSTRUCTION PLANS



7.2 PROCESS AND EFFICIENCY CONTROL

We currently believe that keeping control of the Process Lanes means maintaining current production level by producing accurate products in the planned manhours. This means sending only the planned material to each stage within the required time period.

However, in order to maintain and increase our competitive edge, this line of thought is not enough. Our efforts should be in one of two directions depending on the company's long term production plans.

1. Increase the amount of production per manhour.
2. Decrease the manhours per a given production amount.

In order to achieve this goal, various controls are available. In the case of material handling, that is, moving material to its appointed location in a timely manner, we have material control, storage control, and transportation control. The tools used in the efforts are the Unit Parts List and the U.C.M. When considering the accuracy of the products, accuracy control is necessary. This includes manufacturing standards, tolerance standards, etc. Standards should be established as part of the production methodology to be used at A.S.I.

In the case of controlling the amount of production and the number of workers at a work center, a detailed schedule is made for each stage.

The detailed schedule is used also for efficiency control by being able to plot actual working status against the planned efficiency. You can also see good and bad efficiency trends developing.

Sample efficiency control charts have been made using the actual amount of production and consumed manhours in pre-fabrication. This is data from a recent three (3) month period.

Pre-fabrication is divided into two sections:

1. Marking and Burning
2. Bending

Therefore, the objects for efficiency control are:

1. Total pre-fabrication efficiency tendency
2. Marking and burning efficiency tendency
3. Bending efficiency tendency

Other control charts may be used for sub-divisions of the two (2) main sections.

The basis of initial process scheduling (prior to contract) are the manhours needed for a given amount of production. It is very difficult at this stage to accurately gauge work volume; so, we find a factor which is directly proportionate to manhours and use it instead of work volume.

In the case of pre-fabrication, we use the pre-fabrication weight which is proportionate to the manhours and may vary depending on the type of vessel.

Suppose that the following budget was given to pre-fabrication prior to construction of the vessel:

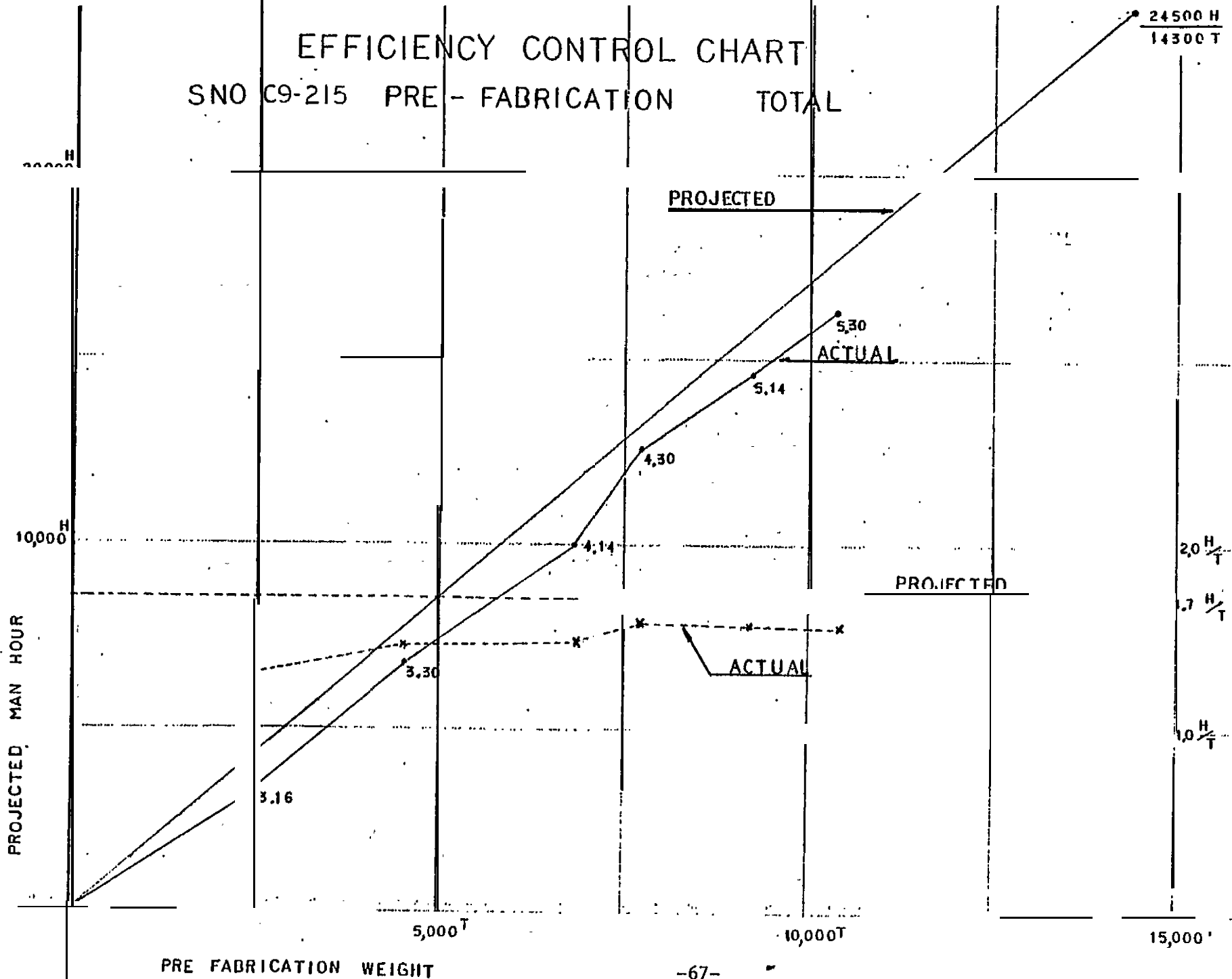
HULL STEEL WEIGHT	14,000 tons	
MARKING AND BURNING	21,500 hrs.	1.5 h/t
BENDING	<u>3,000 hrs.</u>	<u>0.2 h/t</u>
TOTAL	24,500 hrs.	1.7 h/t

The expected efficiency is calculated to be 1.7 h/t and the sample control charts (Figs. 5-7) indicate this. The actual manhours consumed on the A.P.L. from March through May have been plotted using 1.7 h/t as the guide.

The primary purpose of these charts is to identify bad tendencies, investigate the causes and take appropriate countermeasures. On the other hand, when the efficiency shows good tendencies, investigate its causes, also, and take appropriate steps to keep them.

EFFICIENCY CONTROL CHART

SNO C9-215 PRE - FABRICATION TOTAL

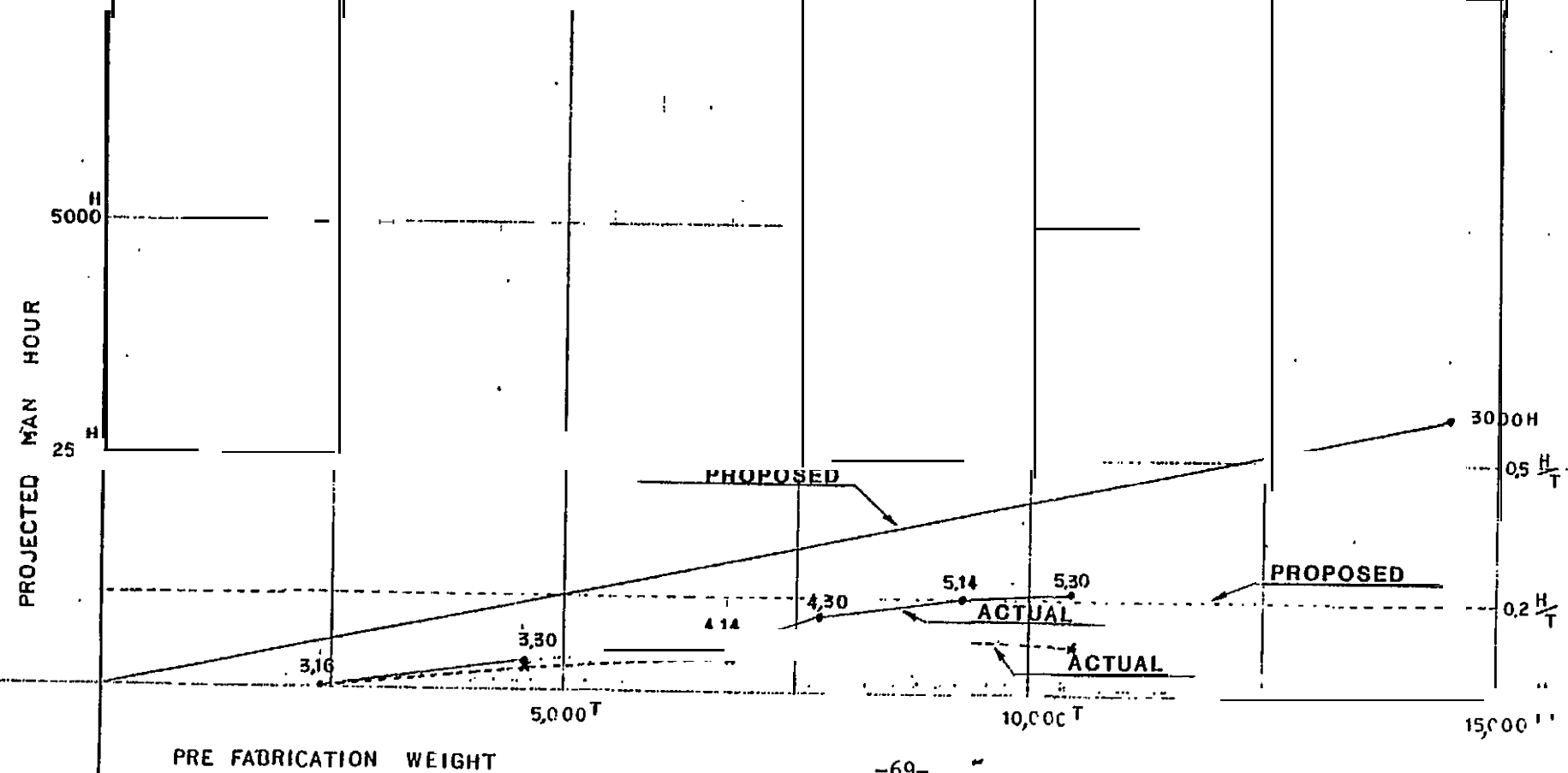


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EFFICIENCY CONTROL CHART

S NO C9-215 PRE FABRICAT ON BENDING



7.3 STAGE PLAN

The Process Lanes Committee has primarily addressed four stages of hull construction - Pre-Fabrication, Fabrication, Sub-Assembly, and Main Assembly. There are two other areas of hull construction that have been mentioned, but not discussed in detail. They are the Panel Line and Erection, two important work centers. These two operations will remain in their present location and will fit in with our Process Lane operation.

Stage plans are documents vital to Process Lane operations. Stage plans are documents used in IHI shipyards. Avondalers stage plan will be the Unit Control Manual. Our UCM was developed in the Mold Loft with other IHI representatives in the past year. It is produced on CADAM/CRT's based on:

1. The Unit Parts List from Engineering
2. The Unit Drawing from Engineering
3. The Unit Summary Sheet from Production Planning.
4. The SPADES Hull Data Base and N.C. Parts File which is used to determine what information goes in each stage plan. The Planning Summary Sheet and the Engineering Parts List must be written, based on the policies of construction methods, as established by Process Lanes.

The UCM was made for 81 Zapata units, for yard *use*, to establish feed back and produce an effective document. It contains all the information in our present unit book, plus detailed drawings, for each operation of hull construction. It is broken down into six sections - (1) cutting list, (2) partial sub-unit, (3) panel line, (4) sub-assembly, (5) main assembly, and (6) erection.

The UCM, along with material transfers, work orders, and schedules, is necessary for supervision and workers to perform their operations efficiently with uncluttered, detailed information. Worker will be given only the sheets of the UCM that are required to perform his operation for his job site. Shop Planners and Superintendents will have the complete UCM to aid in production control and planning.

The Process Lane production system calls for the level loading of work centers, based on their capacity. This is accomplished by the establishment of stage scheduling, produced by Shop Planners. Their purpose is to ensure proper material flow and develop detailed shop schedules, based on the master schedules and the capabilities of the work centers. This is accomplished daily. In addition to this work, he is responsible for maintaining the efficiency charts of the work centers, as previously discussed. Shop Planners also need fitting and welding lengths (now produced in Production Engineering), as well as weights of components (from Steel Control Department) to accomplish his task.

Our committee reviewed the UCM as it relates to Process Lanes requirements. With only a couple of minor additions, we feel those requirements would be satisfied. The entire operation from Key Plan, Hull Drawings, Numerical Control, UCM, Planning, Material and Production Engineering should be reviewed to further eliminate duplications and to improve the overall operations.

INDEX TO SECTION EIGHT: COST REDUCTION STUDY

8.1 PROCESS LANES EFFECTS UPON
EXXON COSTS

8.1 PROCESS LANES EFFECTS UPON EXXON COST

The Process Lanes Committee, for several months, has been evaluating the Process Lanes concept and the subsequent effect it will have upon the cost of the steel hull construction of the Exxon vessels. After much debate and analysis, the Process Lanes Committee established, upon the agreement of all members, that a cost reduction of 21% in hull manhours was achievable-under the proposed Process Lanes concept.

To illustrate the manhours savings, we use the actual manhour per ton cost of the first vessel of the Ogden contract. The Ogden cost figures were chosen primarily due to the similarities of the hulls. Also, the Ogden is a recent commercial vessel for which the hull construction has been completed; thus, very little change in skill level and facilities have occurred since construction.

The projected hull manhour cost for the Exxon contract under our present method of construction would be 513,773 manhours. Under the proposed Process Lanes concept of construction, a reduction of 21% in the hull manhour cost would result in a savings of 106,812 manhours. A sizeable savings is achievable under the Process Lanes concept.

There are five main areas that are affected by Process Lane implementation. These areas will be addressed individually. They are:

1. Process Lanes
2. Material Flow and Handling
3. New Production Methods
4. Accuracy Control
5. Others

As each area is discussed, items will be listed that are now *cost* factors that Process Lanes implementation will affect. There are some items that may belong in more than one area; however, these items will be listed in only one.

Area 1. PROCESS LANES

The implementation of Process Lanes will allow for the clarification of material flow with proper flow procedures. This will help overall production efficiency and will promote the improvement of material handling methods. Also, the large reduction in material delays and the establishment of material queues, which will occur with the Process Lanes concept, will reduce the idle time of workers waiting on material, resulting in considerable manhour savings in the fabrication and assembly areas.

Schedules will be written and platens loaded which will permit material and workers to progress sequentially from operation to operation, until the product has been constructed and outfitted at the most optimum manufacturing cost. The Process Lane will allow work functions of individual workers to remain similar; thus, worker efficiency will increase as the worker becomes more familiar with his work. The line balancing of each Process Lane will allow for the calculation of the most economical manpower distribution, thus, allowing the evaluation of manpower reductions or allowing for the reduction of the fabrication and assembly time periods by allowing us to specify work area as progressively related operations with approximately equal times for each operation.

The Process Lanes concept will allow for the establishment of a stage control system for each production area which will allow area managers to evaluate each area on a regular basis.

This continuous efficiency check will allow the area manager to monitor and control each area for optimum efficiency.

Area 2. MATERIAL HANDLING AND FLOW

A projected cost savings of up to 47% in the main storage area can be realized through the implementation of Process Lanes. Process Lanes will eliminate the need to send material from pre-fabrication to storage, and then to the work center. Material flow will by-pass general storage and, in most cases, go to smaller work center storage queues. The material flow reduction will result in a reduction in the amount of manpower and equipment needed to perform the material handling operation. Also, the eliminated storage area may be developed into a productive area.

Material handling is a major cost to shipyard operations. In many cases, it requires capital that is not working-for the production operation; thus, material handling procedures should be established which allow shipyard operations to work efficiently. A material control system should be developed which will insure that shipyard production is not hampered due to the lack of required material or, for that matter, a surplus of material. Material control personnel should be assigned to specific work areas responsible for the receiving verification, locational assignment, and the exiting of construction material, and have the responsibility of monitoring work queue buffers so as to expedite any material problems. Material control personnel should follow procedures developed for obtaining and storing required material such that a minimum cost is expended on the material handling function.

Process Lanes will allow for the establishment of a hull work pallet system. The palletizing system will greatly reduce the amount of material handling in the fabrication and-assembly area. The system will result in less material damage and a large reduction in material loss.

Material will be easy to locate and will be grouped in one area, reducing the time spent in material search by the field personnel.

Area 3. NEW PRODUCTION METHODS

Process Lanes will require the early study of piece nesting by the Engineering Department. Proper nesting plans will allow for greater utilization of steel and improved scrap ratios.

With Process Lanes, the division of the ship into specific units for Process Lane Production will be required. The Planning Department must divide the units of a ship so that these units can be adaptable to a particular Process Lane and can be produced at optimum efficiency.

Process Lanes will require manpower to prepare detailed schedules of all area activities. The cost of these area planners will justify itself by the coordination of all shipyard activities from raw material to finished product. These planners will prepare proper area loading schedules which will assure proper completion times and costs.

The Process Lanes concept will require the elimination of our present multi-hull cutting system and the establishment of a single hull cutting system. The single hull cutting system will require more cutting time for multi-hull contracts. The cost of this extra cutting time may be offset by the savings incurred by not having to recut material due to mistakes or revisions. Also, the single hull cutting system will allow for a large reduction in cut steel storage. Savings on the investment of previously stored material and the excess of usable estate will help offset the cost of the extra cutting time.

The committee acknowledges the fact that proper accuracy controls must be established for the proper development of Process Lanes. With PROPER ACCURACY CONTROLS, the elimination of the stock on parallel midbody sections will allow for the ease of the fitting activities and will result in a reduction in fitting manhours. A projected savings of 9.5% in erection cost could be realized as a direct result of eliminating stock at hull erection joints. The

elimination of scribing, burning, and welding edge preparations, along with the elimination of the double pulling in of sections, will result in considerable savings.

With Process Lanes, the fairing of distorted plates should be performed by the most economical method available and in the most economical stage of construction. The Accuracy Control Department should issue guidelines on when, where, and how this work is to be performed by field personnel.

Process Lanes will promote the increased use of pin jigs. However, pin jigs will require precisely curved shell plates. Studies indicate that the use of pin jigs will reduce expenditures in the fabrication of fixed jigs.

Area 4. ACCURACY CONTROL

Proper accuracy control procedures is one of the most important prerequisites to Process Lane development and maintenance. The implementation of proper accuracy controls throughout the shipyard will result in a sizeable savings in fitting manhours in the fabrication, assembly, and erection stages of constructions. The amount of necessary checks in the shipyard can be drastically reduced by the introduction of a system of coordinated activities which prevent the manufacture of a product from deviating from what is typically expected.

A projected direct-labor cost increase of 0.5% at the pre-fabrication stage is anticipated to establish the dimensional and accuracy control program and the documentation necessary for anticipated cost reduction in fabrication, assembly, and erection stages. A projected savings of up to 6.0% at the assembly stage can be realized as a direct result of accuracy controls in preceding stages.

If pre-fabricated parts and fabricated parts are dimensionally accurate, assembly work should be constructed with appreciable savings. A projected cost savings of up to 13.0% at the erection stage can be realized through dimensional and accuracy control by the elimination of racked or distorted assemblies, the reduction of internal members having to be left loose for alignment and the subsequent welding of same in erection.

Area 5. OTHERS

The establishment of Process Lanes will reduce the amount of stored material and subsequent lost material and will allow for the establishment of material flow procedures. These changes in conjunction with proper accuracy controls will reduce the total pre-fabrication, fabrication, and assembly remakes and result in a direct savings of material and manhours.

If the drawing schedules precede the parallel Process Lane schedules in all Engineering sections, the decreased number of drawing revisions and subsequent U.C.M. revisions will greatly reduce the cost of remakes. Also, the standardization of working pieces, such as lifting lugs and padeyes as controlled stock items, will greatly reduce the cost of material and manpower to produce these items.

A projected savings of 4.0% in the pre-fabrication, fabrication, and assembly stages is anticipated in the cost of remakes due to the elimination of multi-ship burning, anticipated decreases in drawing or unit book revisions, the establishment of material flow procedures, and the standardization of working pieces.

With the establishment of Process Lanes, there will be an initial creation of specialized platens for the manufacturing of different types of ship units with little or no future platen modification; accordingly, platen modification cost will be reduced. Also, since Process Lanes will require detailed schedules of all area

activities, it will assure proper completion dates and may allow for a reduction in night shift personnel.

After investigating the five (5) areas mentioned, the committee concluded that improvement in work efficiency will be evident throughout all stages of ship construction. Conclusions show that upon the establishment of the Process Lanes concept at Avondale Shipyards, with all the necessary supporting functions, that there will be a 21% reduction in hull manhour cost and subsequent increases in platen productivity.

INDEX TO SECTION NINE: RECOMMENDATIONS

9.1 RECOMMENDATIONS FOR IMPLEMENTATION
OF PROCESS LANES AT AVONDALE SHIPYARDS

9.1 RECOMMENDATIONS FOR IMPLEMENTATION OF PROCESS LANES AT AVONDALE SHIPYARDS

- 1) Develop a "turnover" station at Platen 20 by designing appropriate "turning feet" for use with existing cranes.
- 2) Complete leveling and reinforcing of flat platen jigs on Platen 20 prior to start of Exxon contract.
- 3) Remove all structural work from Plate Shop and relocate to Platen 18. Relocate angle bender, frame bender, and punch press from Plate Shop to Platen 18B.
- 4) Fabrication of work tables for Platens 23, 24, and 16 to facilitate assembly line web frame fabrication.
- 5) Design, fabricate, and install 30" high flat platen jigs on Platens 17 and 14 to accommodate the Category No. 2 and No. 5 units scheduled for those Process Lanes, along with the four appropriate pin jigs.
- 6) Relocate tab burning operations for nested N.C. plates from material storage area to the Plate Shop and install the N.C. burning machine (currently in storage) in the Plate Shop for this purpose. Those pieces which require beveling to flow within shop to the beveling area. Those pieces for Category No. 1 units to transport via rail car to Platen 23/24. Those pieces for Category Nos. 2, 3, 4, 5 to transport to Platen 16 (except Category No. 3, for Westwego).
- 7) With the establishment of the work queue at each work center, there is a need for accurate material control. It is recommended that the Material Control Department be responsible for all material movement and all inventory accounting at each

work queue. The Material Control Department should be aware and have records of all material at all times in each work queue.

- 8) Accuracy Control should develop detailed procedures that the line foreman at each work center can follow to assist him and his mechanics to check the accuracy of each block of work, both in terms of dimensional accuracy and in terms of assembly tolerances to determine that each piece is accurately cut, formed, fabricated, and assembled correctly PRIOR TO THE PIECE moving to the next stage. This committee feels that all errors should be corrected where they occur and not be passed on to the next stage of construction to be discovered and/or rectified.
- 9) Study the feasibility of railroad tracks to run from the Plate Shop to Platens 23, 24 and 16 for transportation of pre-fabricated material to those work centers. A small electric or diesel driven dolly car could be utilized for this purpose. The tracks should run the full length of Platens 23 and 24.
- 10) Purchase and install two (2) 75 ton bridge cranes for Platens 17 and 14, rather than two (2) 50 ton cranes.
- 11) Fabricate the pallets for transportation of the fabricated partial sub unit from the fabrication stages to the assembly stages.
- 12) Set up a line heating station in the Plate Shop in way of removed angle rolls.

INDEX TO SECTION TEN: SYSTEM SKETCHES

10.1 ISOMETRIC DRAWINGS OF TYPICAL UNIT
CATEGORIES AND HANDLING SYSTEMS

10.2 TYPICAL FROM/TO CHART

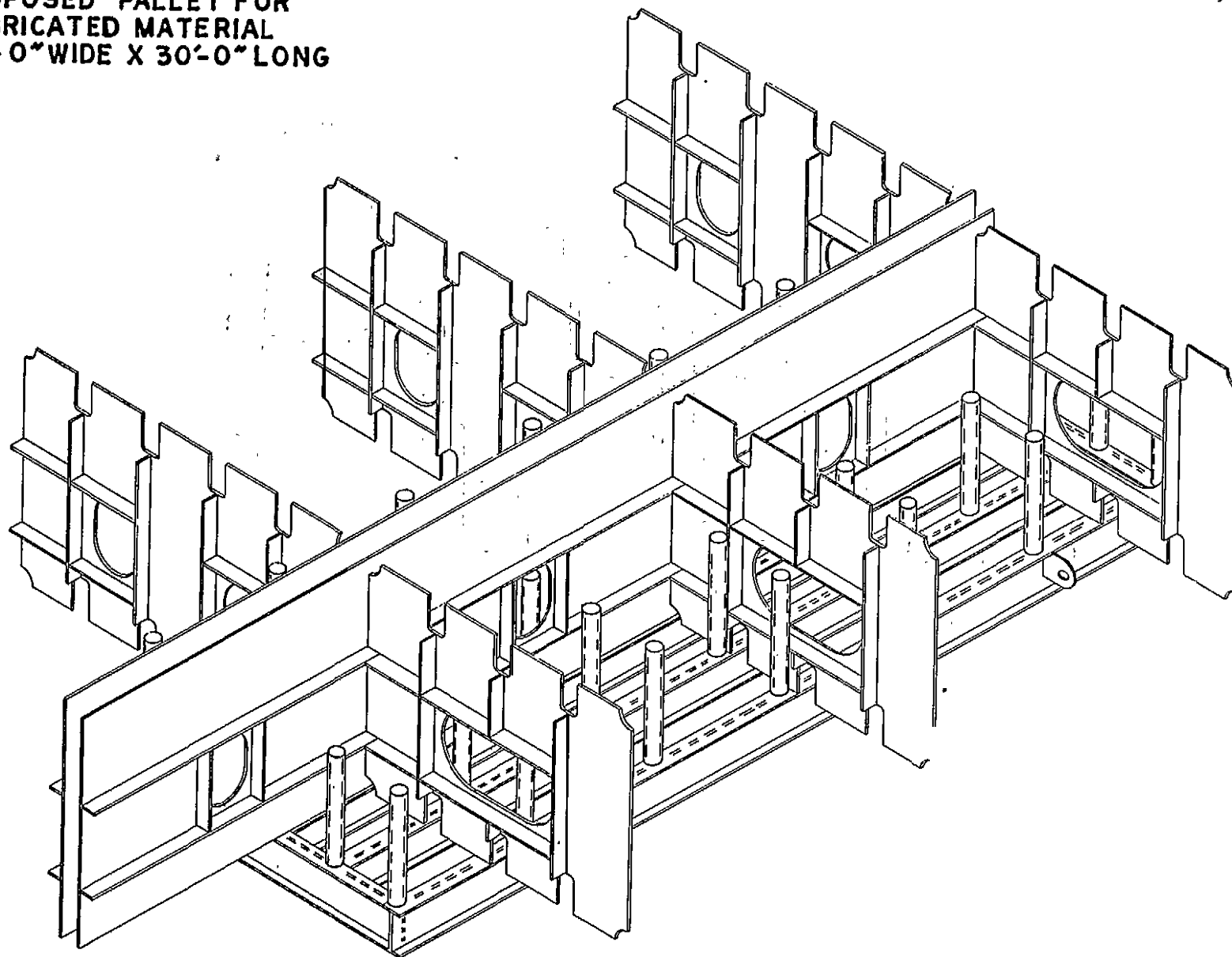
10.3 PRESENT AND PROPOSED PLATEN
MATERIAL HANDLING

10.4 PRESENT AND PROPOSED STEEL STORAGE
MATERIAL HANDLING

10.5 PROPOSED PLATEN LAYOUT
PLATEN 20 "TYPICAL"

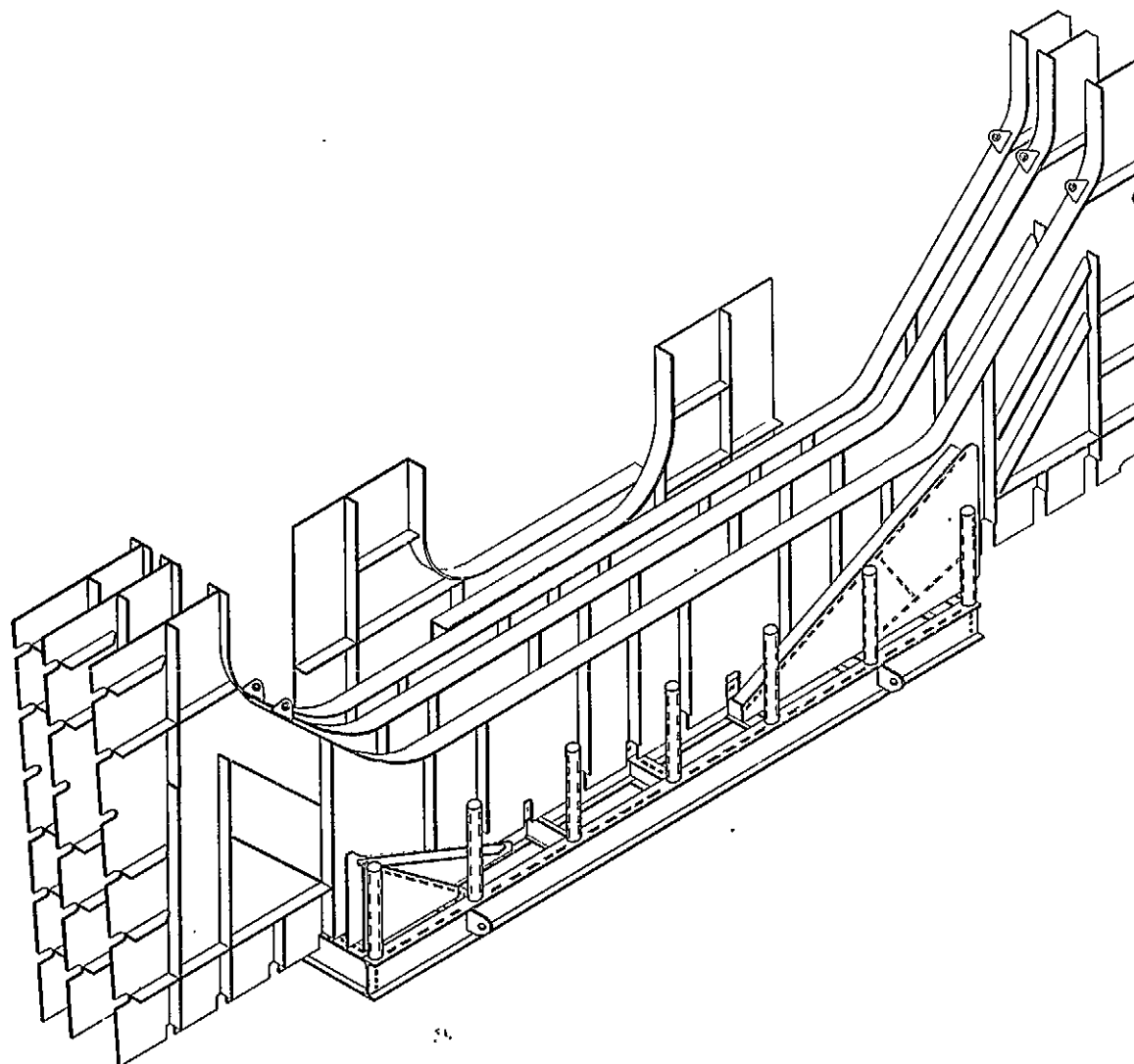
SEQUENCE NUMBER 1

**PROPOSED PALLET FOR
FABRICATED MATERIAL
10'-0" WIDE X 30'-0" LONG**



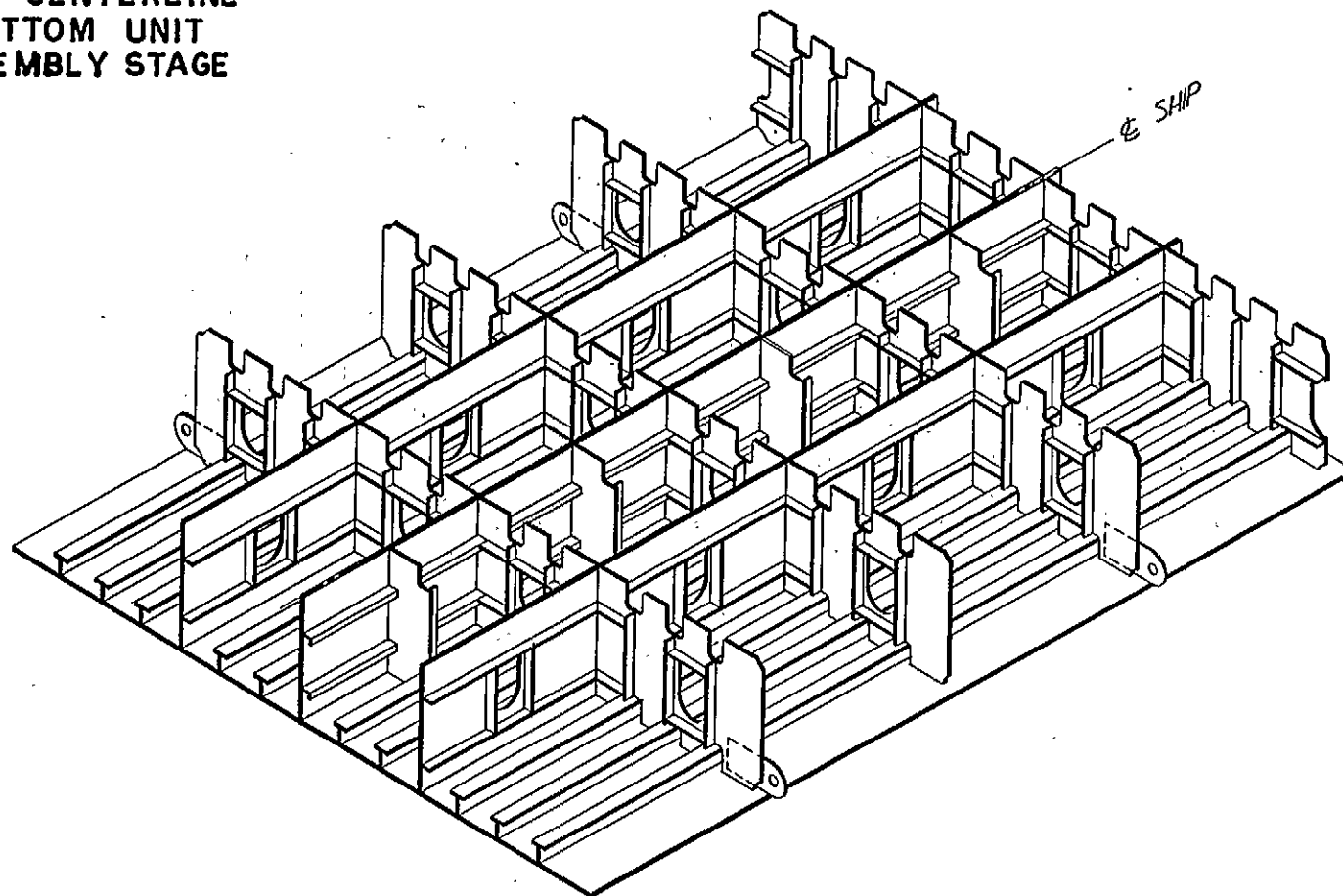
OPERATION SERVICES

SEQUENCE NUMBER 2
PROPOSED PALLET FOR
FABRICATED MATERIAL



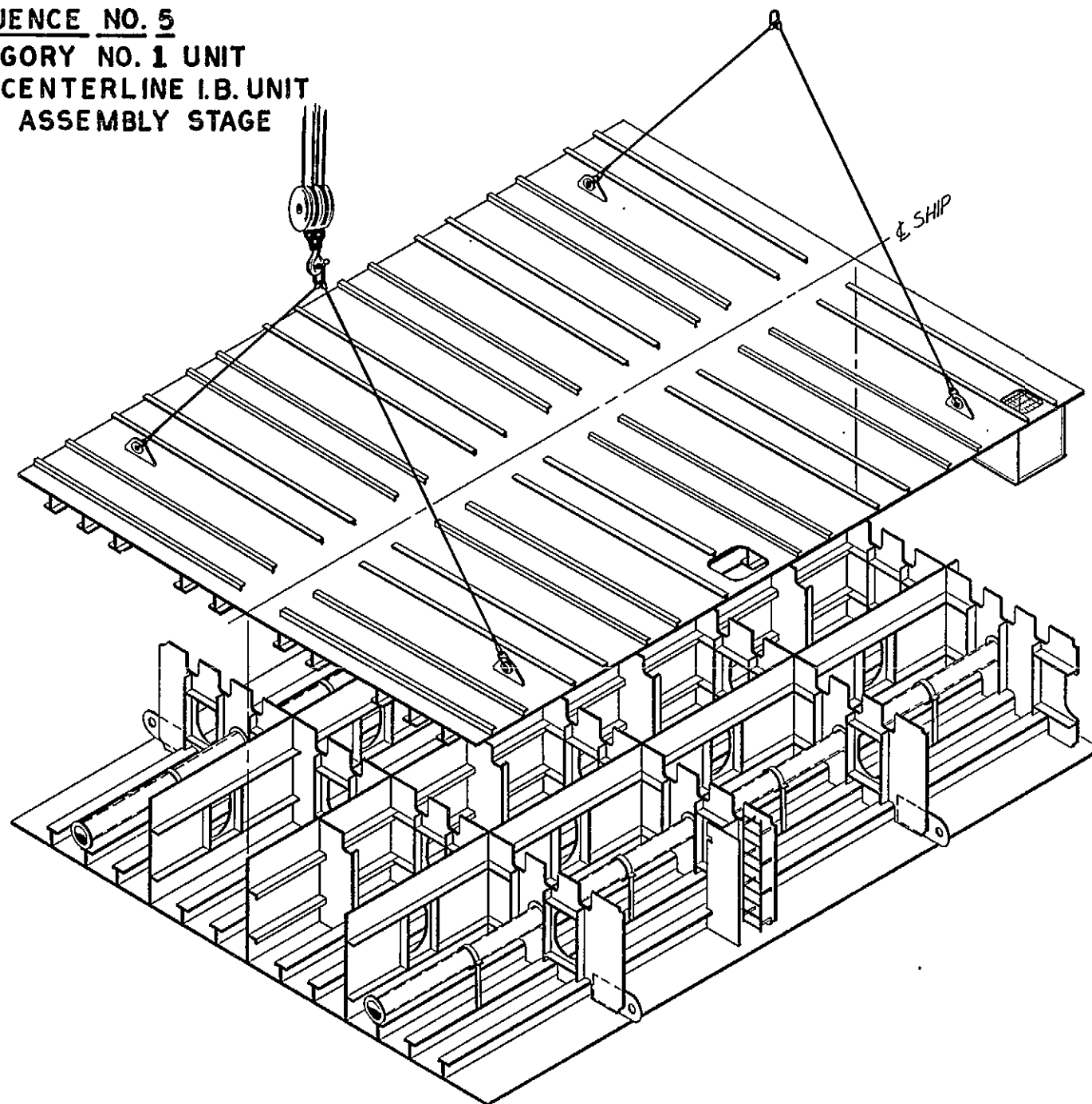
SEQUENCE NO. 3

CATEGORY NO. 1 UNIT
TYPICAL CENTERLINE
INNERBOTTOM UNIT
SUBASSEMBLY STAGE



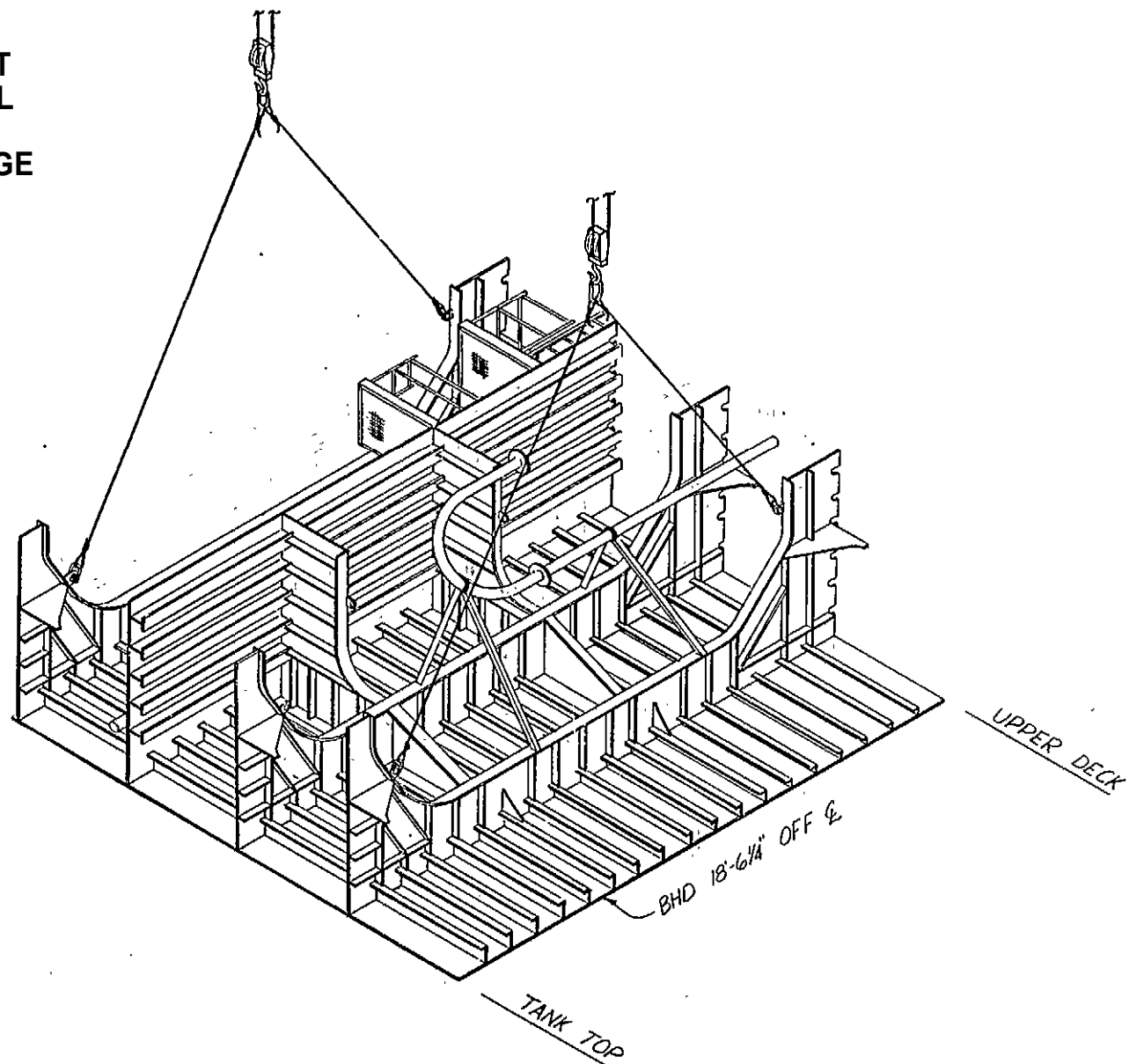
OPERATION SERVICE:

SEQUENCE NO. 5
CATEGORY NO. 1 UNIT
TYP CENTERLINE I.B. UNIT
MAIN ASSEMBLY STAGE



SEQUENCE NO. 12

**CATEGORY NO. 1 UNIT
TYP INBOARD LONG'L
BHD WING TANK
PREOUTFITTING STAGE**



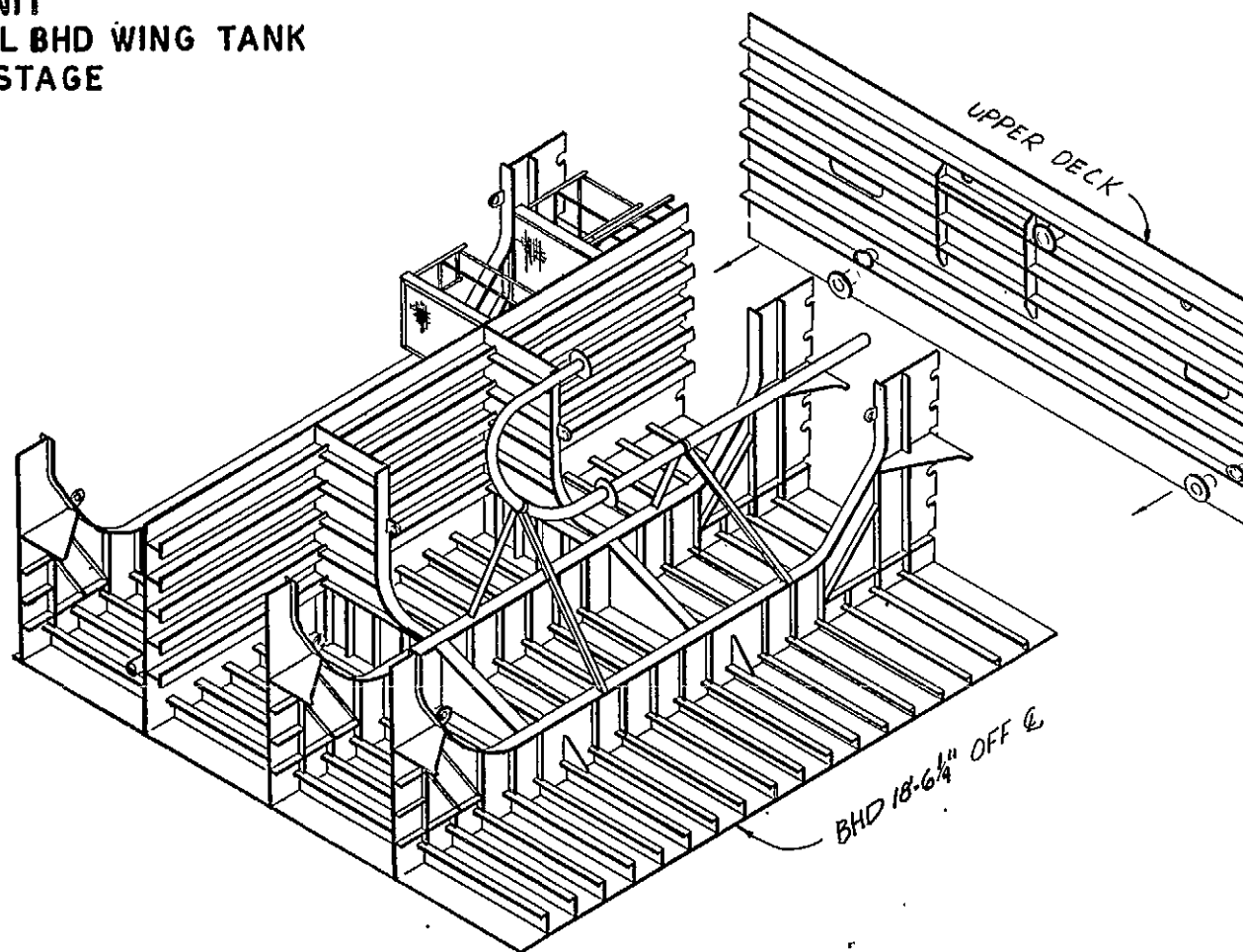
OPERATION SERVICES

SEQUENCE NO. 13

CATEGORY NO. 1 UNIT

TYP INBOARD LONG'L BHD WING TANK

MAIN ASSEMBLY STAGE

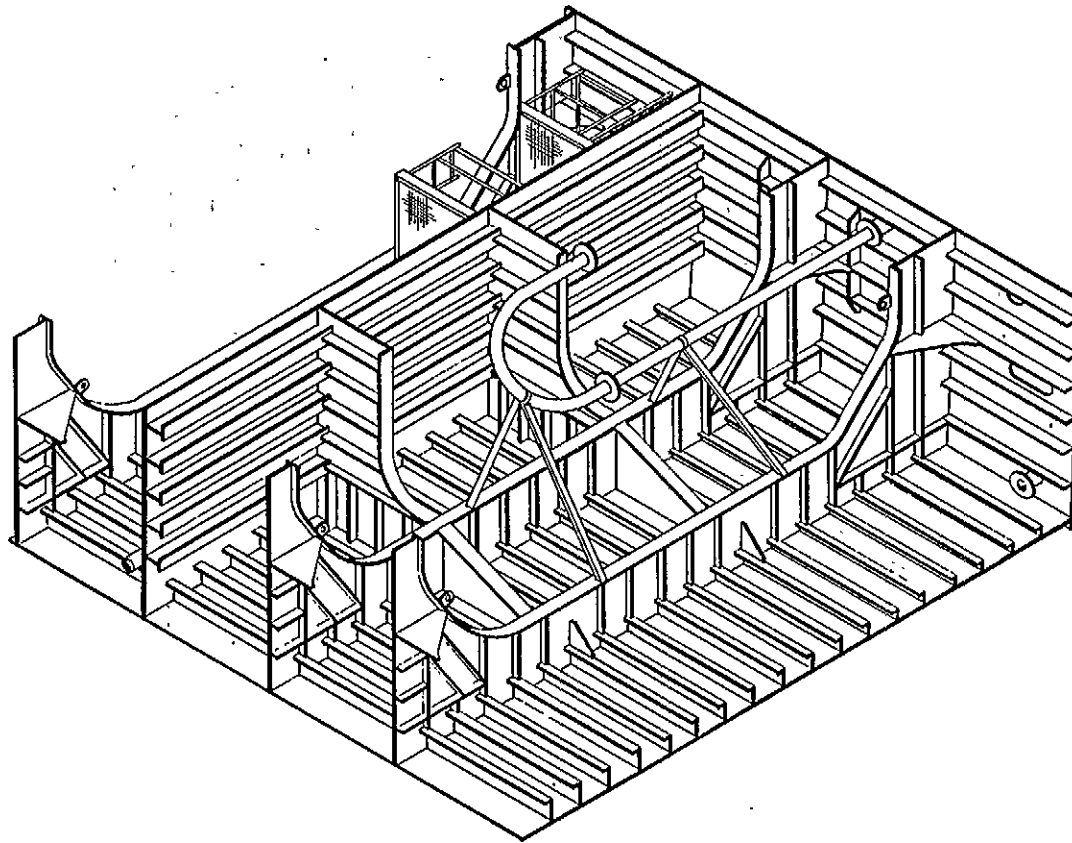


SEQUENCE NO. 14

CATEGORY NO.1 UNIT

TYP INBD LONG'L BHD WING TANK

FINAL MAIN ASSEMBLY STAGE

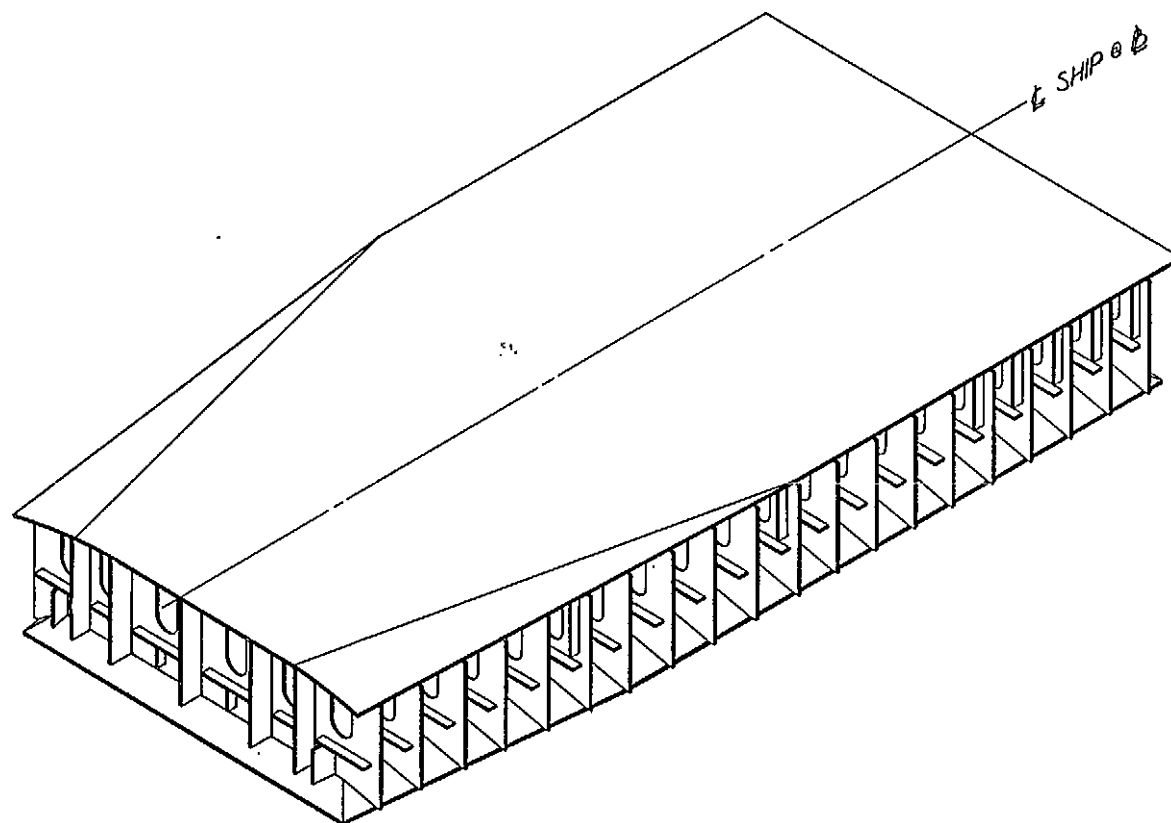


OPERATION SERVICES

SEQUENCE NO. 35

CATEGORY NO. 5 UNIT

TYP ENG RM DBL BOTTOM

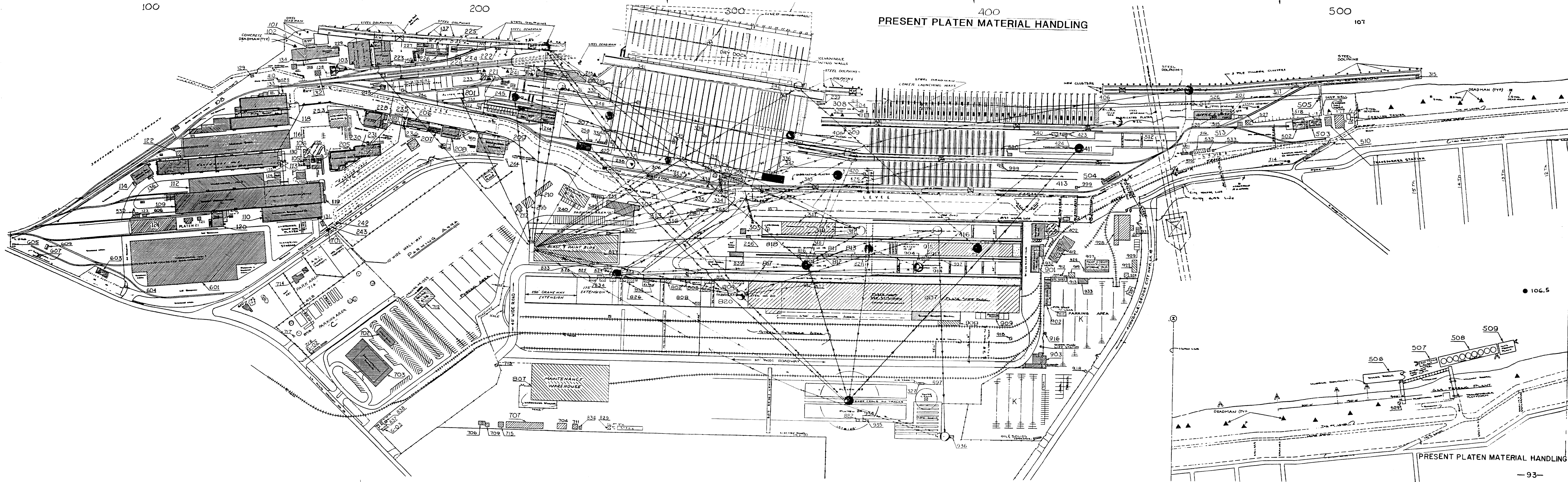


OPERATION SERVICES

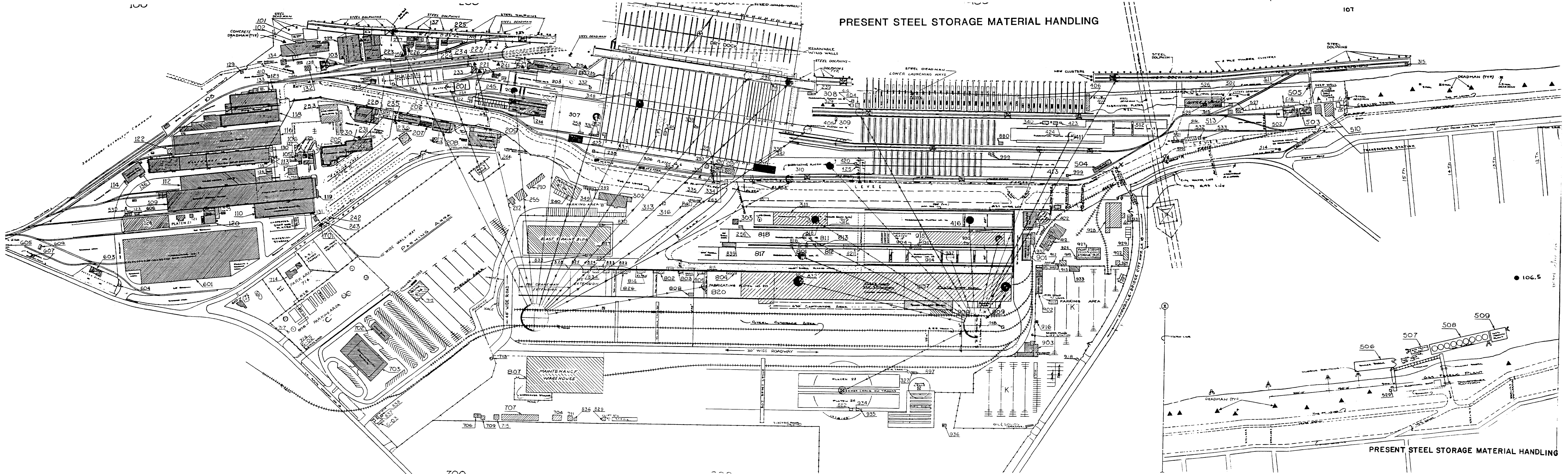
TO FROM	PRESENT PIECES MOVED PER WEEK																							
	FAB STORAGE	STEEL STRG.	PLATE SHOP	PLATE LINE	PLT 1.	PLT 2.	PLT 3.	PLT 4.	PLT 5.	PLT 6.	PLT 10.	PLT 11.	PLT 14.	PLT 15.	PLT 16.	PLT 17.	PLT 18.	PLT 19.	PLT 20.	PLT 22.	PLT 24.	DRYDOCK	T-BEAM	SHOP 1.
FAB STORAGE		1.8	34.5	7.1	6.2	4.6			278	1.9	135	6.0	282	197	1.6	322	243	210	82	57	148	122		9.2
STEEL STRG.	9.		85	20	26.5	6.5	2.7		23.9	6.6	1.7	2.7	6.2	52.7	265	17.6	9.5	5.5	1.2	1.0	35.2	106		89
PLATE SHOP	24.12	2.4		134	55				9.4	2	14.5	118	13.2	2.8	39.6	185	80	249	116	7.4	23.4	257	9.6	136
PANEL LINE	5.13																							
PLT 1.																								
PLT 2.																								
PLT 3.	1.2		.3																					
PLT 4.																								
PLT 5.			.2																					
PLT 6.																								
PLT 10.																								
PLT 11.																								
PLT 14.																								
PLT 15.	463		3.8										2.3	1.2	.5									
PLT 16.		.2																						
PLT 17.																								
PLT 18.	385	54	1.1						1.0	9.0														
PLT 19.	1.2								5.2															
PLT 20.	1.7																							
PLT 22.																								
PLT 24.	4	14.7	.1																					
BLACKSMITH	75.3		.6																					
MARINE WAYS																								
DRYDOCK																								
T-BEAM																								
SHOP 1.																								
WD 1.									11.3					2.1		154								
WD 2.																								
WD 3.			1.4																					
BLAST AREA	1.1								3.6	.9														
AREA "B"	4.8																							
AREA "K"																								
GT 4.																								
GT 5.																								
GT 10.																								
GT 14.																								
GT 16.																								
GT 23.																								
GT 24.																								
9174.0	2780	2.4	143	60	1674	677	7.3	3.6	318.3	2.1	115.4	117	388.5	0	207	4114	298	716.5	773	1274	137	25.5	1.0	62.5

"TYPICAL FROM/TO CHART"

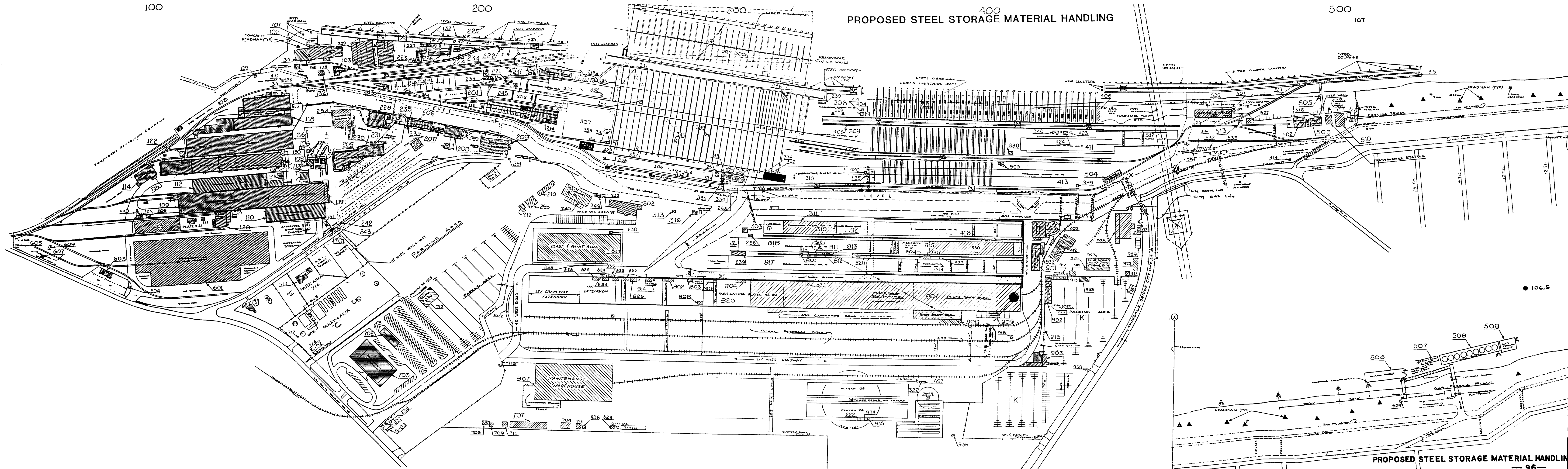
PRESENT PLATEN MATERIAL HANDLING

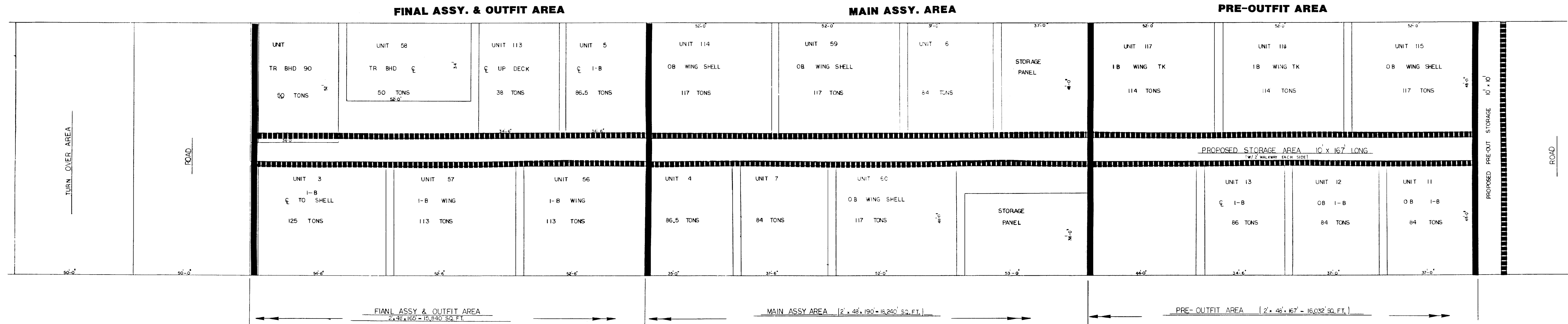


PRESENT PLATEN MATERIAL HANDLING



PROPOSED STEEL STORAGE MATERIAL HANDLING

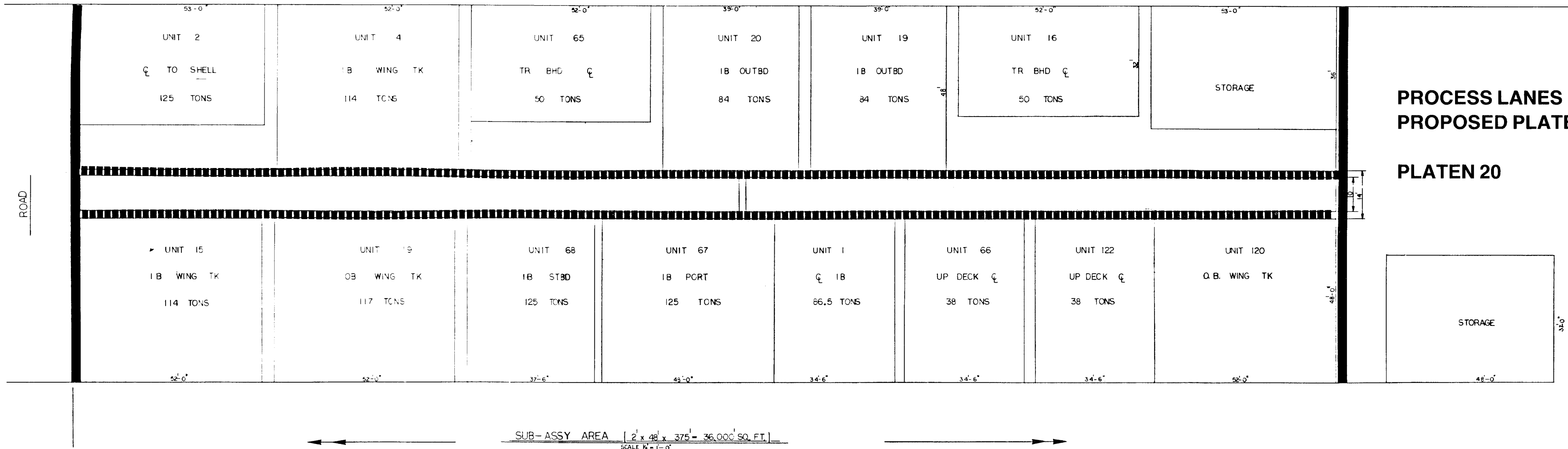




PROCESS LANES
PROPOSED PLATEN LAYOUT

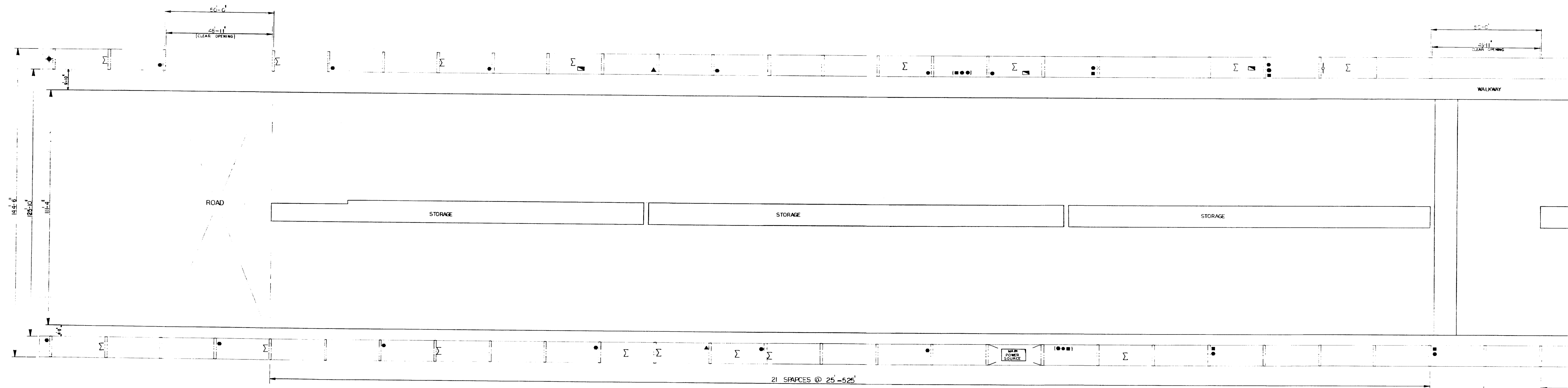
PLATEN 20

SUB-ASSY. AREA



PROCESS LANES
PROPOSED PLATEN LAYOUT

PLATEN 20



ID FOR SYMBOLS	
○	AIR
●	FRESH WATER
■	FIRE WATER
▲	GAS & OXYGEN
●	GAS, OXYGEN & ARGON
Σ	CIRCUIT STATION 8 OUTLETS
◆	FIRE PLUG
■	WELDING & TACKING MACHINES
■●●	MAIN VALVES

**PROCESS LANES
&
UTILITIES
&
STORAGE
PLATEN 20**

